for . . .

engineers and contractors controlling the design, specification, installation and maintenance of heating, ventilating and air conditioning.

HEATING AND VENTILATING

The Air Conditioning Monthly

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CONTENTS FOR NOVEMBER, 1942

VOLUME 39 NUMBER 11

National Broadcasting Company	21
Tests at Cornell Show Insulation Affects Radiator Heat Output	26
The Theory and Practice of Pneumatic Conveying	28
How U.S. Houses Are Heated	33
Reference Section No. 7 — Lighting and Air Conditioning	35
Reference Data 233 and 234	46
Profits in Air — Glenn L. Martin Company	48
Profits in Air — War Industries	50
Profits in Air — Midwest Ordnance Plant	52
Profits in Air — Munsingwear, Inc.	53
Washington News	54
Degree Days for September, 1942	57
News of the Month	59
Industrial Degree Days	62
New Equipment	64
Reviews of Technical Publications	66
New Catalogs	72
Coming Events	75
H&V's Photos	75

THIS MONTH'S COVER

The completely air conditioned Radio City of the National Broadcasting Company in San Francisco. Particular attention was paid to vibration-isolation in this building and this, as well as the air conditioning, is described by S. E. Locke, the designer of the air conditioning, in an article beginning on page 21.

MEMBER
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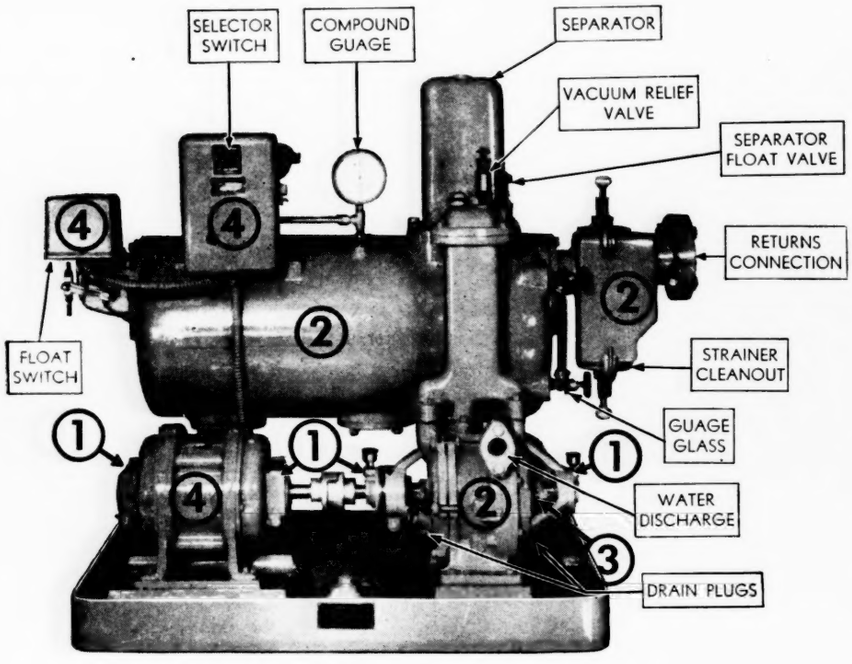
How to keep your Jennings Heating Pumps in First Class operating condition for Duration...



YOUR JENNINGS RETURN LINE VACUUM HEATING PUMPS

are an important part of plant or building equipment. They cannot be easily replaced and must last for a long time. Jennings Pumps are designed for long life, and have extra capacity which will count when it may be difficult to maintain lines and equipment free from leaks, but to give full service they must have proper care.

Now that these pumps have been in service all winter on the heating system, they should have a thorough inspection. Special attention should be given to the bearings, as no wearing contact occurs in a Jennings Pump as long as the ball bearings are properly maintained.

In most cases Jennings Pumps will require only the check-up we have recommended. If additional adjustments or repairs are found to be necessary, they should be undertaken at once. Do not wait until both time and materials are running short. Nash Service Branches are established throughout the United States. If you do not know the address of the one nearest to you, write directly to this office. Nash Service is yours to command, NOW.

SERVICE POINTERS

1 LUBRICATE PUMP AND MOTOR BEARINGS . . . Check bearings for end play, or radial play, and be sure they contain no grit, or foreign matter. If found to be clean and in good condition, fill with proper non-acid grease lubricant. If motor has oil lubricated bearings, flush out with fresh oil, and refill.

2 CLEAN STRAINER AND STRAINER SCREEN . . . Clean strainer well and strainer screen. If screen is found to be worn, and has passed foreign matter, thoroughly flush both receiving tank and pump casing. Drain plugs are conveniently located . . . Damaged screen should be repaired or replaced at once.

3 RENEW STUFFING BOX PACKING . . . Remove old packing and clean stuffing box. Fill with new loose-woven graphite-impregnated stuffing box packing, in individual rings. Be sure joints are staggered, and that ends butt properly without over-lapping. Do not finally tighten gland until pump is again in operation.

4 HAVE MOTOR AND CONTROL INSPECTED . . . Have an experienced electrical service man go carefully over motor and control. Follow his recommendations and if repairs or replacements are indicated, have the work done immediately.

5 CHECK OPERATOR'S INSTRUCTION BOOK . . . If operating instructions originally furnished with the pumps have been lost, write to us at once for a new copy for each pump. BE SURE TO FURNISH US THE TEST NUMBER OF EACH PUMP, as stamped on the pump name plate.

6 IF PUMPS REQUIRE REPAIRS . . . and you do not know the address of our nearest Service Branch, notify us at once, and we will have our Service Engineer get in touch with you without delay . . . There are well equipped Nash Service Branches in most principal cities, ready to give you every possible help.

NASH ENGINEERING COMPANY

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Exterior view of San Francisco's completely air conditioned new Radio City. The building contains 52,800 sq. ft. of floor space and has 10 studios, the largest accommodating 500 people.

NATIONAL BROADCASTING COMPANY

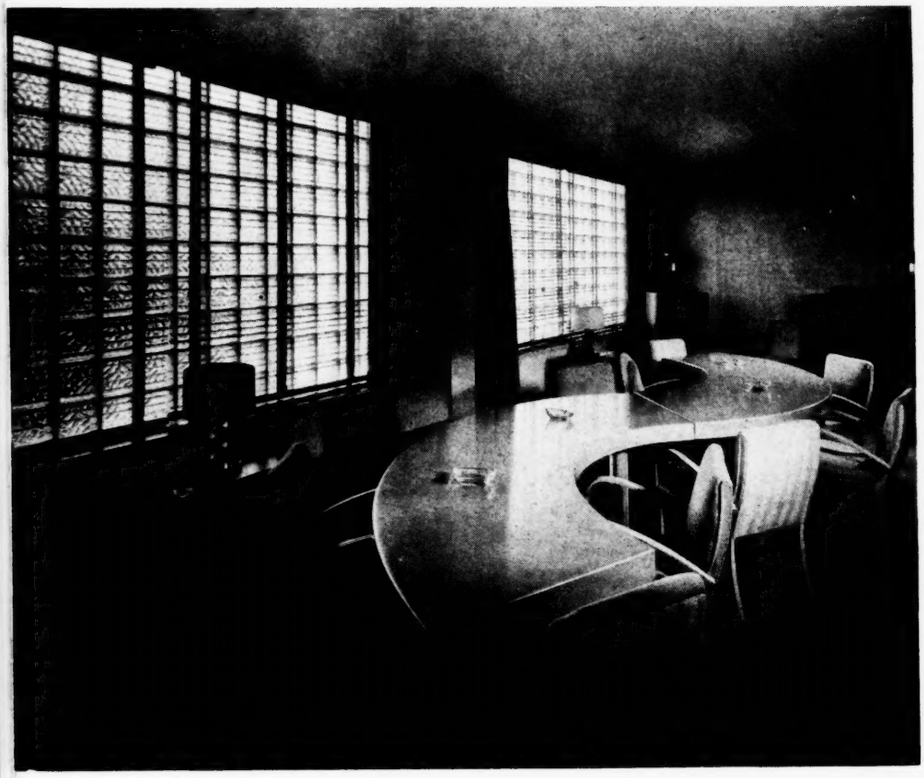
completely conditions its San Francisco Radio City plant, with studios vibration-isolated. Building is windowless, with extensive application of glass blocks. Air conditioning here described by S. E. Locke.†

FEW structures offer such challenge to the air conditioning engineer as that of a building to be used exclusively for radio broadcasting. In addition to the usual problem of proper temperature and humidity control and adequate zoning, the problems of sound and vibration control are of paramount importance. Not only must there be a total absence of noise or vibration due to operation of the air conditioning equipment, but the problem of intercommunication of sound between adjoining studios through the air conditioning ducts is of major importance.

The recently completed National Broadcasting Company plant in San Francisco has been acclaimed in many quarters as the most efficient and nearest perfect plant of its kind ever designed and built. Regardless of the accuracy of this claim it is certain that with the completion of the plant and the inauguration of its operation San Francisco now ranks high among the broadcasting centers of the nation.

With the total investment well in excess of one million dollars, many features of unusual interest have been incorporated. Experiences in similar previous projects in other cities were drawn upon to a great extent in determining the desirable and essential features of design and construction. The architecture is modern and streamlined, but not freakish, fantastic nor faddish. The new plant will give the two stations, KGO and KPO, 52,800 sq ft of floor space, more than double that of their previous quarters. The structure is of reinforced concrete, five stories high; is windowless, and includes ten studios, the floor of each studio resting on springs, with the walls and ceilings being similarly suspended. The largest of these studios will accommodate audiences of 500 people. All wall surfaces have scientifically correct acoustical treatment and are set at angles

†President, Western Air & Refrigeration, Inc., Los Angeles, Calif.

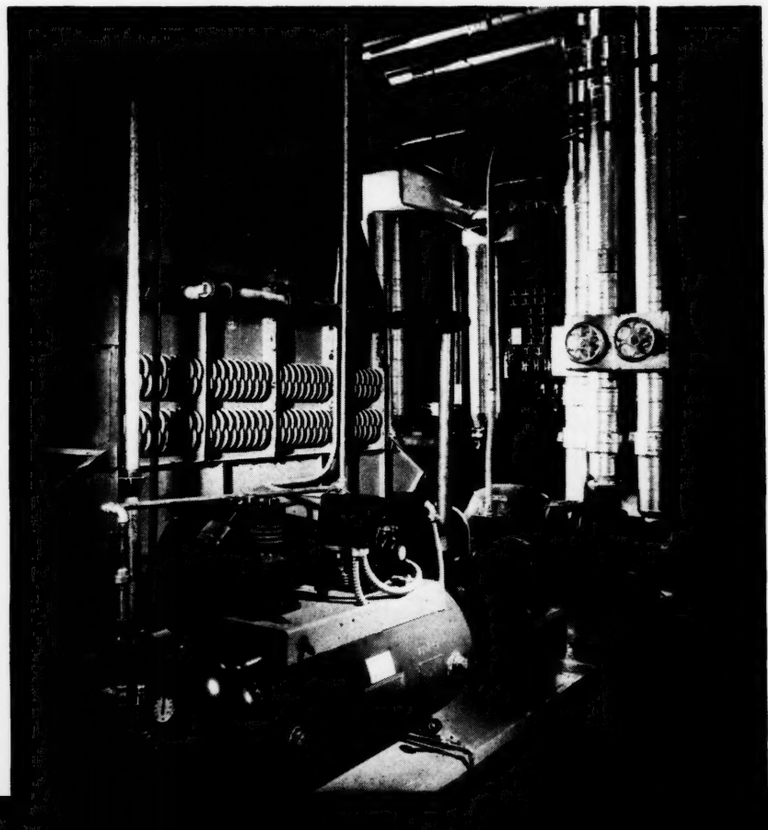


A striking feature of the client's audition room is the sinuous gray finish maple table. The walls of this room are of perforated hardboard behind which rock wool has been placed to absorb all sound.

that make echoes and sound reflection impossible. The plant is completely air conditioned. Except for a public parking garage in the basement and a portion of the first floor, the entire structure will be devoted exclusively to broadcasting — a compact, well-arranged, beautifully designed structure — an ideal combination of radio studios, offices and facilities.

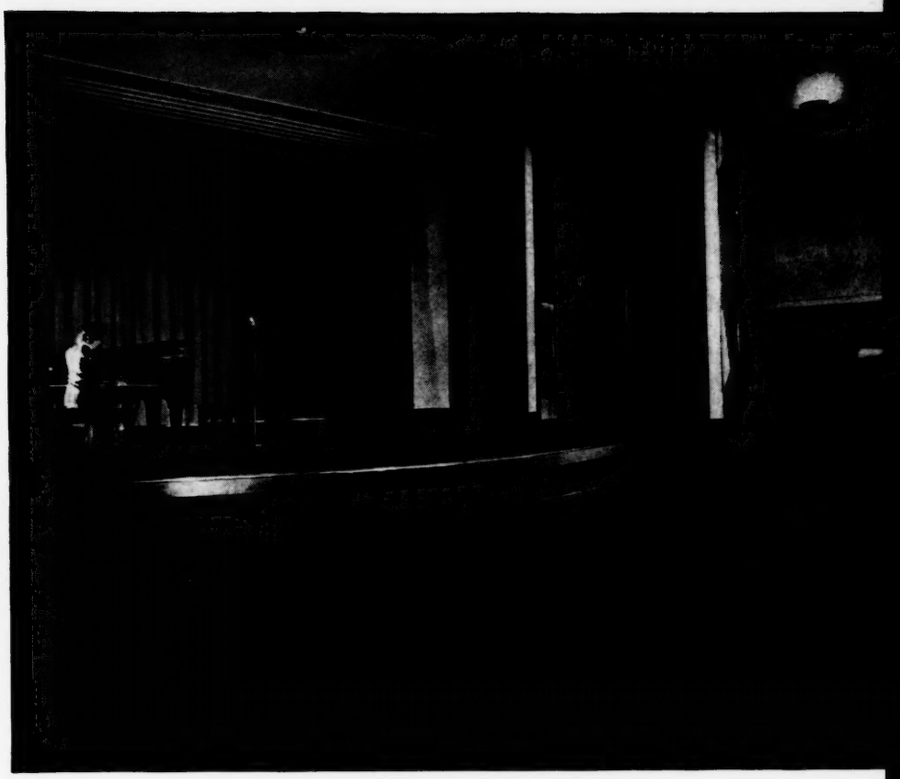
Air Conditioning and Acoustics

The refrigerating and air conditioning equipment is located in a penthouse above the fourth floor of the building below which, on the second and third floors, is the main studio area. The initial problem then was the complete isolation of the equipment foundations from the building structure itself as such vibration transmitted into the building structure would surely result in disturbances in the studio areas. This problem was met in the following manner: The refrigeration equipment, consisting of two 40 hp Westinghouse freon compressors, with evaporative condenser and water chilling unit; the air compressor for the Johnson Service Company temperature control system; and the Buffalo chilled water circulating pump and the circulating pump for the evaporative condenser, was installed on a single concrete slab, the combined weight of slab and equipment being approximately 90,000 lb.



Left foreground, Johnson Service air compressor supplying air for pneumatic controls system. The Westinghouse evaporative condenser is shown behind the compressor. Water chiller is at the right.

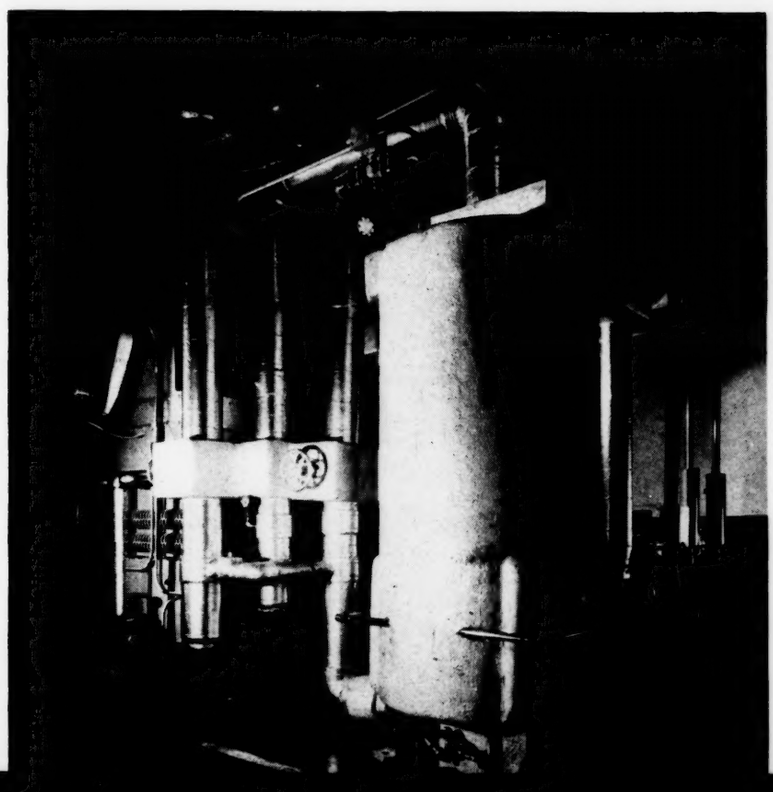
Corner of one of the studios showing air supply units in the ceiling. The grilled work at the front of the stage is a return air grille.



This machinery slab was isolated from the floor of the penthouse by means of steel coil springs, approximately 300 in number, which were uniformly loaded to provide a deflection of approximately 1 inch. Wherever it was necessary to support water or refrigerant piping from the ceiling of the penthouse, spring type pipe hangers were used. This arrangement worked out most satisfactorily and there is a virtual absence of machinery vibration in the building structure.

All of the Buffalo Forge Company supply and exhaust fan equipment for the building is located in the same penthouse and this equipment is also mounted on coil springs in a manner similar to that described for the refrigerating equipment.

The type of system employed makes use of chilled water circulated through copper fin type coils for temperature and dew point control. A dew point of 50F is maintained the year 'round and conditioned air for the studios and offices is reheated by means of finned type air heaters to which steam is supplied from a low pressure gas-fired Pacific steam boiler. The offices and entrance lobby are also provided with Trane concealed type steam convectors with manually controlled radiator valves. There are ten separate zones of temperature controls for the



The Westinghouse chilled water cooler with a capacity of 65-110 tons. At the extreme left is the Buffalo circulating pump for the evaporative condenser, shown in the background.

Modern lighting and air conditioning, coupled with furnishings in good taste, make this a pleasant and efficient secretarial office.

Corner of a spacious air conditioned office in the new building. Insulux glass blocks furnish effective lighting, and also reduce the heating and cooling load.

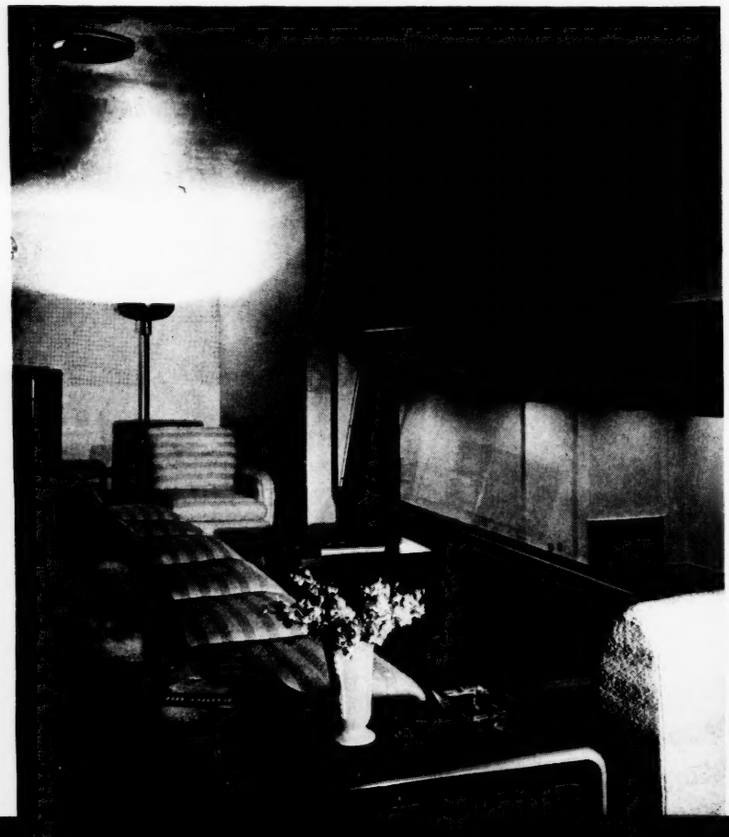
studios, control rooms and client's booths and four zones of control for the offices.

Light and Insulation

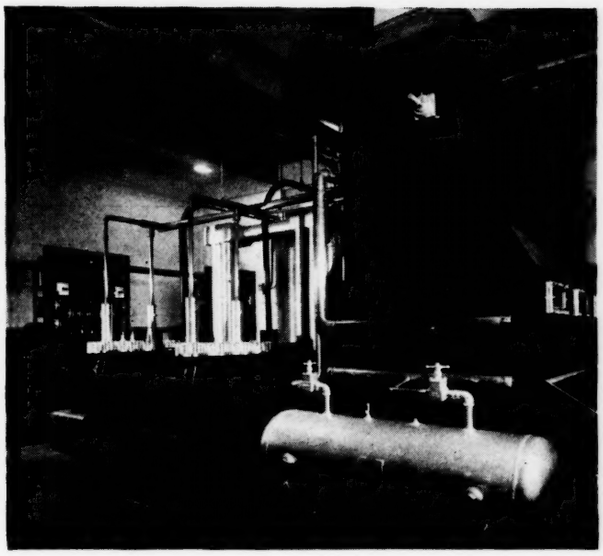
There are three continuous bands of Insulux glass blocks on the exterior walls of the building which provide daylight for the offices on the second, third, and fourth floors. These are on the south and west walls and are provided with inside Venetian blinds. This method of construction makes the task of zoning for sunlight gain somewhat easier than would be the case with the conventional type of glass windows, and also affords a reduction in heating and cooling load.

Air Distribution

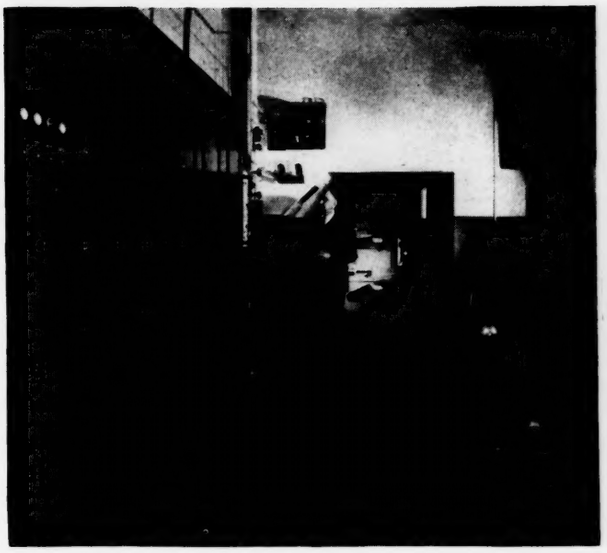
Each studio's duct system is a complete unit from the supply fan to the supply openings located in the studio ceilings. Anemostats are used for these supply openings. The return system from each studio to the return fan is also a separate unit distinct from each of the other return ducts. This type of insulation is considered essential in order to prevent communication of sound between studios. All supply and return ducts are wrapped with 2 in. rock wool blanket. In addition all supply ductwork is lined with ½ in. balsam wool blanket. In each supply duct, just ahead of the supply openings to the studios, there is a sound cell, 16 ft long, built up with interior steel baffles wrapped with balsam wool. When supply or return ducts pierce the studio walls the metal duct is stopped on each side of the wall and the connection between is made with a canvas collar which in turn is wrapped with 4 in. of mineral wool blanket. The return risers, which



Air conditioned observation booth in the NBC building in San Francisco. In the ceiling one of the Anemostats is shown.



Air conditioning equipment penthouse located atop the tower section of the building. The floating, sound-isolating concrete slab is shown in the left foreground.



Electrical panel board and controls, located in air conditioning equipment penthouse. About 190 miles of electrical wire were used in the complete building.

are furred into the studio walls, are connected to the return grilles by means of a canvas collar also wrapped with 4 in. of rock wool blanket. Similar construction is also used where the riser is connected to the main duct. Metal duct hangers are isolated from the building structure by heavy felt pads.

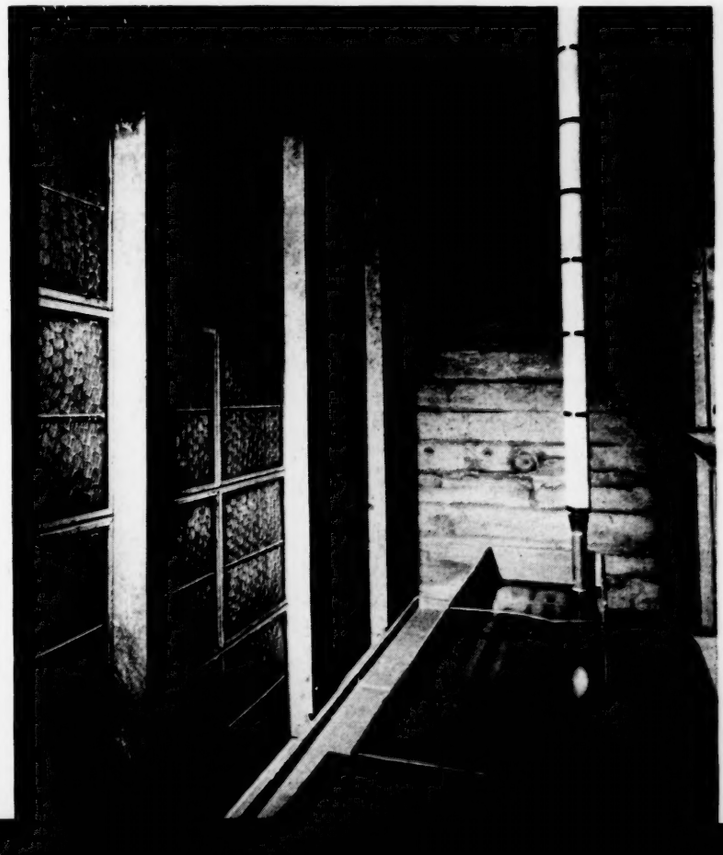
All apparatus casings are lined on the inside with 1 in. air acoustic sheets in addition to 2 in. rock cork insulation on the outside of the casing.

The system is designed to maintain inside conditions of 72F dry bulb with 45% relative humidity during all seasons of the year. The capacity of the system is 41,210 cfm, an amount sufficient to completely change and condition the air of the plant every seven minutes. All outside air is filtered through 4 in. Dustop Fiberglas filters to remove suspended foreign matter.

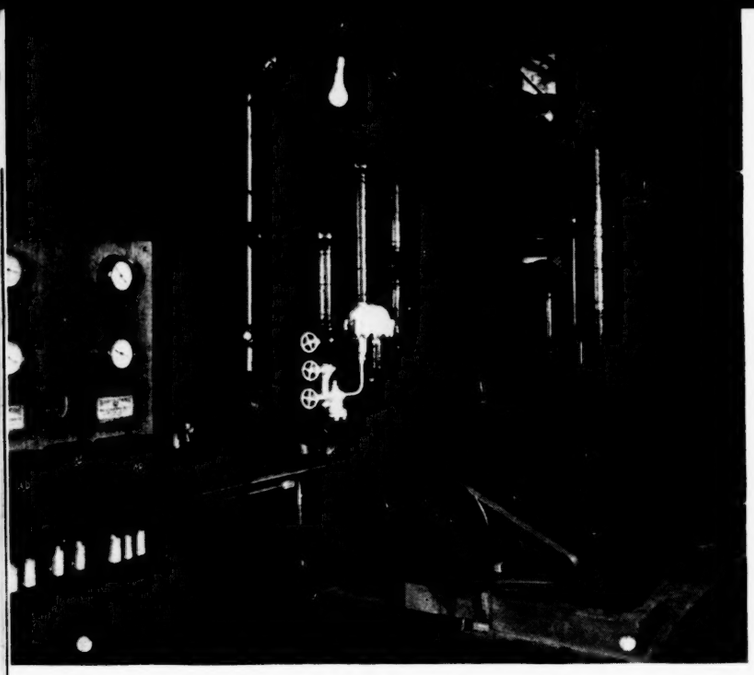
Controls

Humidity control, apart from considerations of human comfort, is essential from an operations standpoint inasmuch as past experience has demonstrated that the tone quality of pianos, stringed instruments, and drums is affected by changing relative humidity. It is, therefore, of prime importance to have the same relative humidity in the studios during broadcasts as prevailed during rehearsals.

Located in the master control room is a Brown electric resistance remote type indicating thermometer which indicates the temperature prevailing in each of the fourteen separate zones. Readings from this thermometer are taken at regular periods by the operating staff as a check on the operation of the Johnson automatic temperature control system.



Fiberglas filters in the machinery penthouse remove dust and dirt from the returned air as well as outside air in the air conditioning system.



Ammonia compressors used to provide cooling for the constant temperature room.

Tests at Cornell Show Insulation Affects Radiator Heat Output

A SERIES of tests conducted recently at the newly-constructed heat transfer laboratory of Cornell University indicated that radiator heat output is affected by insulation, the size of the radiator, and, to a lesser extent, by the number and arrangement of windows. The investigations, which were under the direction of Dr. David Dropkin, instructor in Experimental Engineering, had as their main objective the determination of the effects of these three different factors on the heat output of radiators during standard rating tests. Dr. Dropkin has completely described the set-up, test method, and results in Cornell's Engineering Experiment Station Bulletin 29 entitled "Some Factors Influencing the Heat Output of Radiators," on which the following is based.

The test set-up consists of a constant temperature room, a cooler room, and an instrument room, with the radiator test room built inside the constant temperature room. The radiator test room was built to conform as closely as possible to the ASHVE test code specifications. It is 15 ft long, 12 ft wide, and 8 ft 2 in. high, made up of demountable wooden frame sections which can easily be taken apart. Test room walls and ceilings are of ⅛ in. hard pressed Masonite board backed up by studding on 16 in. centers. One-quarter inch Masonite was used for the floor. The ceiling, floors, and four walls were successively insulated during the various tests and the effects on radiator output noted. This additional insulation consisted of 3 in. mineral wool and ¼ in. plywood sheeting. One standard size 1⅜ in. wooden door provided access to the room and the inside of the structure was finished with flat gray paint. Air from the cooler room cooled by refrigeration equipment of 15 tons capacity is blown into the constant temperature room at the proper temperature. This air temperature is automatically controlled to give a standard test temperature in the test room. Temperature in the constant temperature room can be regulated anywhere over a range from —50F to +100F. The arrangement by which the air is supplied to it from the cooler room is shown in the illustration, as is also the thermocouple arrangement and radiator set-up under which the various tests were made. During all tests steam at 31.9 in. of mercury absolute pressure, with a slight amount of superheat, was maintained in the radiator. Three continuous bleeders were used.

The series of tests recently completed showed that:

(1) If two radiators of the same design are tested individually in the same test room, the one containing the larger number of sections will show the higher heat output per section. A 40-section radiator gave 6% greater output per section than did a 12-section.

(2) Test room insulation affects the heat output of a given radiator, if the application of insulation is not complete and perfectly uniform. The largest increase in output occurred when the entire room, except for the wall immediately back of the radiator, was insulated. This increase was 6% for a 12-section, 5-tube radiator and 8.6% for a 12-section, 6-tube radiator. If the entire surface of the room, including the wall back of the radiator, were uniformly insulated, the output per section would be the same as when no insulation was used.

Insulation of the ceiling accounts for the major portion of this increase, it being responsible for 4.4% of the total of 6% increase which occurred when the floor, ceiling, and three walls were insulated.

The 30-inch level is a better height than the 60-inch level for the temperature control point of the test room. The radiator output was less affected by partial insulation of the room when the control point was at 30 in. than when at 60 in.

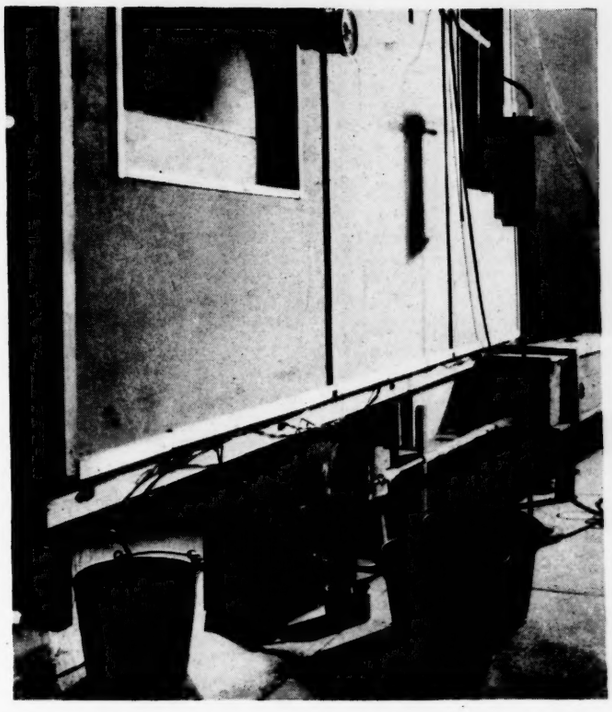
(3) With infiltration of air kept at a minimum the insulation of two windows in a standard test room had a negligible effect on radiator output except when the radiator was placed directly in front of one of the windows. In that case, the output was increased 2.4%, due to increased radiation directly through the window.

(4) Air temperature at the inlet to a radiator

should not be used as an index of the radiator output. Room insulation affects the inlet air temperature for a given radiator output.

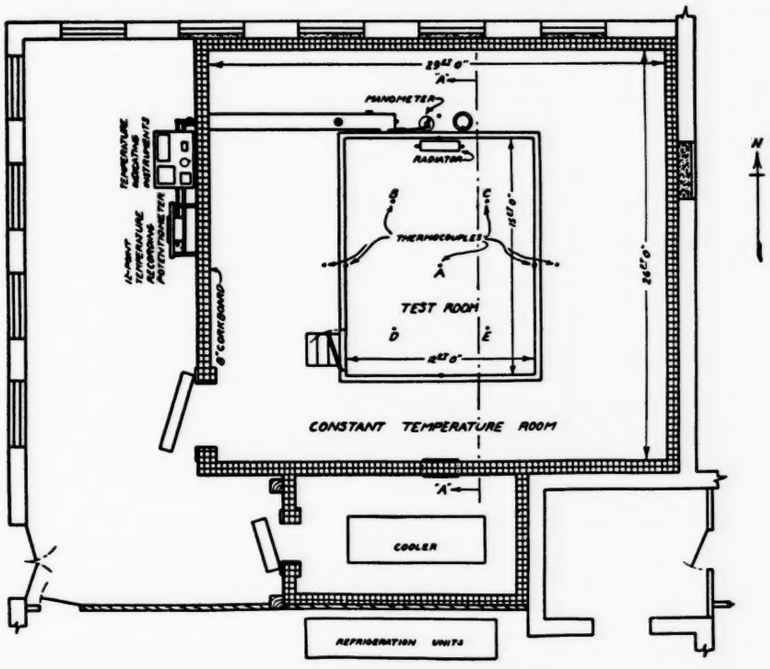
(5) A comparative method of test based on condensation can be used for the rating of radiators. This method is simple and with certain precautions should yield results well within 2.5% accuracy. It consists in symmetrically connecting to the same steam line two radiators, one whose output is known and one whose output is to be determined, and comparing the condensates. The radiators must be alike in general construction, of about the same size, and be similarly exposed to natural convection.

For an understanding of some of the results, it is necessary to keep in mind certain relationships and conditions of the test. The radiator in each case was kept at a constant temperature, due to the steam pressure being constantly at 31.9 in. of mercury absolute, and the steam, of course, being dry. The test room likewise was kept at a constant temperature during each test, the control point being at the center of the room and either 30 in. or 60 in. above the floor. The room was either uninsulated, or insulated over various portions of its area. The temperature at the control point of the test room was controlled by controlling the temperature of the air in the room surrounding the test room. In other words, the temperature gradient between inside and outside of the test room was varied so as to increase or decrease the heat transfer through the walls by whatever amount was necessary to hold a given control point temperature in the test room under the various conditions of the tests. Thus, referring to result (1) more radiator sections meant cooler inside wall temperatures with consequently greater radiation per section, since heat transfer by radiation is proportional to the fourth power of the difference in temperature between the hot body and the cold body (walls).



Exterior view of the test room showing the condensate collector, the pressure manometer, and miscellaneous equipment.

Similarly, in regard to result (2) with the entire room except the wall behind the radiator insulated, and for a given size of radiator, a greater heat loss must occur through the uninsulated wall to make up for the decreased losses through the insulated portions. This means a lower temperature for the air surrounding the test room, a lower inside temperature for the uninsulated wall, and consequently an increased rate of heat output per section by radiation to the colder wall.



Plan of heat transfer laboratory. The test room is of Masonite panel construction, entirely contained within the constant temperature room, with ample clearance above and below and around the sides for good air circulation.

The Theory and Practice of Pneumatic Conveying

By J. M. DALLA VALLE

Engineer and Consultant, Kruse Engineering Co., Newark, New Jersey.

Pneumatic conveying is somewhat of a stepchild in that apparently no group of engineers claims it as part of their own particular specialty. However, ventilating engineers certainly have some interest in this subject, since industrial exhaust systems are, in many cases, a form of pneumatic conveyor and also because any phase of air handling comes more or less within their province. Consequently, due to the lack of published information on this subject, the accompanying article is presented to clarify (1) the determination of required velocities for conveying and (2) the situation as to types of systems employed for pneumatic conveying.

ALTHOUGH pneumatic conveying of powdered materials is being applied more and more to many industrial processes, it is indeed surprising to find so little published information on the subject. This may be due to the fact that the practical aspects of pneumatic conveying problems cannot be predetermined exactly by simple formulation, and that experience or the methods of trial and error are the only procedures left to the designing engineer. As a matter of fact, it may be stated at the beginning that the variables involved are many as well as complex, and there is much to be desired regarding our knowledge of their proper relationships. For example, to mention only the most important variables we must consider (a) particle size, (b) density, (c) concentration of the material conveyed, (d) air velocity, and (e) type of flow (that is, horizontal or vertical). The condition of the pipe line, separators, electrical charge, hygroscopicity, and temperature are other considerations. Not all of these variables can be related, but three are obviously most important and easily related. These are size and density of the material, and the air velocity. Several formulas covering the more elementary aspects of conveying (and containing no other variables) are available. However, these will be discussed in another section. The general theory will first be developed.

Theory

Nature of flow. We shall discuss two types of conveying: (1) low concentrations of material such as are encountered in ordinary exhaust systems; and (2) heavy concentrations, where the primary object is to move a mass of particulate material from one point to another. Fundamentally, there is no theoretical difference insofar as particle movement in itself is concerned, but with heavy concentrations there is an effect of much importance that must be mentioned. Consider a mass of particulate material moving in a horizontal duct. Obviously the heavier particles settle and slide along the bottom; at this point the velocity is a minimum and hence there is a considerable difference between air velocity and particle velocity. Due to turbulence the smaller particles are suspended and move at approximately the velocity of the air. Thus, as in the case of hydraulic conveying, the mass of material moved is concentrated at the lower portion of the duct and the particles are undoubtedly graded as to size. But there are two important differences between pneumatic and hydraulic conveying. Conveying velocities and differences in specific gravities of the material and conveying medium are much higher in the former.

Not all particulate materials are susceptible of pneumatic conveying, and unfortunately no set rules can be given. Fine particles such as are removed by exhaust systems in dusty operations have given much trouble even when velocities of ten to fifty times ordinary requirements were provided. Concentrations from a pneumatic conveying standpoint were relatively low, but over a period of time they tended to "build up" in some horizontal sections and elbows. This may be due partly to hygroscopicity and partly to electrical effects. However, it seems more logical to assume that it is due to the so-called *boundary layer.* As is well known, there is little motion of air close to the inner surface of the duct. Consequently, particles adhering to the

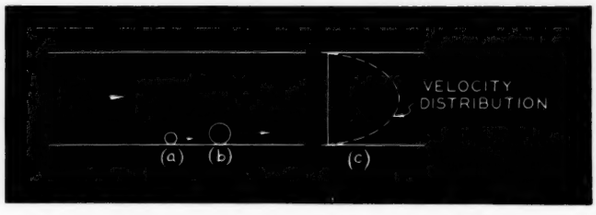


Fig. 1. Drawing illustrating magnitude of velocities acting on two particles of different size.

surface do not move and in turn create a new surface and a new stagnant boundary layer. This effect continues until the accumulated material is removed, usually *after* it is noted that the exhausting system fails to handle the requisite amount of air.

The above effect is rarely noted when a heterogeneous size distribution is conveyed and may be explained as follows: In Figure 1 let *a* and *b* represent two particles, and let *c* be the velocity distribution within the duct. We note that the motion in each case is determined by its diameter and a relatively low velocity; that is, it is a function of the projected surface area and velocity. Hence the larger particle (having a larger projected surface and the air velocity being greater) has a greater tendency to move. These larger particles prevent any tendency of the small particles to accumulate and thus keep the duct clear.

The effect is easily shown quantitatively: If v is the velocity in the duct, then the equilibrium forces on a particle, say of diameter d_1 are given by the equation

$$\frac{\pi d_1^2}{4} \cdot \frac{\rho v^2}{2g} = f \frac{\pi d_1^3}{6} (\rho - \rho_o)$$

where f is the coefficient of friction, ρ the density of the particle, ρ_o the density of the fluid, and g the acceleration due to gravity. Hence

$$v = \left(\frac{4}{3} fg \cdot \frac{\rho - \rho_o}{\rho_o} \right)^{\frac{1}{2}} \sqrt{d} = K\sqrt{d}$$

Thus, if $d_1 = 2d_2$ the velocity of the larger particle requires a bed velocity of $\sqrt{2}$ times that of the smaller. However, the velocity change between the points identified as centers of the two particles is generally more than doubled, so that the coarser particle is more easily moved.

In some cases materials tend to pack and for this reason cannot be moved pneumatically. They clog ducts rapidly, and this characteristic should always be investigated. Often it will be found that packing phenomena are related to moisture content or temperature and humidity. Certain salts may appear to be conveyed easily from one floor to another, and yet days occur when the conveying system fails completely.

Formulas. Of some value are a few elementary considerations relating to the movement of particles in a fluid stream. It is obvious that the terminal or steady-state velocity of a falling particle is just the velocity required to support it. This means that once we have determined the terminal velocity of a given particle we need only exceed it in order to convey the particle in a vertical upward direction. Now the terminal velocity is definitely a function of size, as we know from a consideration of Stokes' law and Newton's law. In the first case we have:

$$v_s = K_s \left(\frac{\rho - \rho_o}{\mu} \right) d^2 \quad \text{.....(1)}$$

and in the second:

$$v_n = K_n \sqrt{\frac{\rho - \rho_o}{\rho} \cdot d} \quad \text{.....(2)}$$

where v_s is the terminal velocity of a particle obeying Stokes' law, v_n that obeying Newton's law, ρ the density of the particle, ρ_o the density of the medium, μ the viscosity of the medium, d the diameter of the particle, and K_s and K_n constants. Stokes' law holds for particles below 35 microns in size ($\rho = 2.65$); above this size, terminal velocities are determined by Newton's law. The division between the two laws as to size is not clean-cut. In the case of air, ρ_o is usually negligible as compared with ρ, so that we may write Equations (1) and (2) as follows:

$$v_s = K\rho/\mu d^2 \quad \text{.....(3)}$$

$$v_n = K_n \sqrt{\frac{\rho}{\rho_o} d} \quad \text{.....(4)}$$

where K_s and K_n are constants dependent only upon the *shape* of the particles. Values of K_s and K_n have been determined for few substances. In general, values of K_s range from 54.5 (the value for a sphere) to about 40 (for crushed quartz), while corresponding values of K_n range from 25.4 to 50. The units are in the centimeter-gram-system.

Equations (3) and (4) have been tested by several investigators. Martin et al (1926-1927), using an elutriation method on silica ($\rho = 2.65$), found excellent agreement in the range of sizes for which Stokes' law applies; that is, for particles below 70 microns in diameter. Between 70 microns and 2000 microns a linear relationship between velocity and diameter was found to hold, in accordance with the early investigations of Allen (1900). The general formula for this region was found to be:

$$v_a = 100 \frac{\rho}{\rho_o} \cdot \bar{d} \left(\frac{d\rho_o}{2\mu} - 10.5 \frac{\mu}{\rho_o} \right) \quad \text{.....(5)}$$

where $\bar{d}$ is the size of the largest particle which settles according to Stokes' law and is determined by the relation

$$\bar{d} = \sqrt[3]{\frac{36\mu^2}{g\rho_o\rho}} \quad \text{.....(6)}$$

where the terms are as before, and g is the acceleration due to gravity. Above 2000 microns, the terminal velocities of particles followed Newton's law. Martin's results for quartz are shown in Fig. 2.

Later work by Burke and Plummer (1928), carried out by suspending particles in an air stream by means of a fine thread attached to a delicate balance, completely verified Newton's law as given in Equation (4).

It is clear that Equations (3), (4), and (5) give the velocities necessary to support a particle in a vertical air stream. Higher velocities than those calculated from these equations must be used to convey the particle. It is also clear that velocities required for horizontal transport may be less than

those calculated from the above equations. The author experimented with various materials ranging in size from 4/6-mesh to 14/20-mesh (Tyler) in an actual conveying system. These are sizes well within the range to which Newton's law applies. The results obtained indicated the following relationships. For horizontal conveying:

$$v_h = 16{,}200 \left(\frac{\rho}{\rho + 1} \right) d^{2/3} \quad \ldots\ldots (7)$$

and for vertical conveying:

$$v_v = 54{,}700 \left(\frac{\rho}{\rho + 1} \right) d^{3/5} \quad \ldots\ldots (8)$$

where ρ is the specific gravity of the material (in every case less than 3.0) and d the diameter of the largest particle to be conveyed (in feet). The conveying velocities required in Equation (8) are much greater than those calculated by Equation (4). From Equations (7) and (8) we note in passing that:

$$v_v = 3.4\, v_h d^{1/5} \quad \ldots\ldots (9)$$

More complicated formulas on conveying velocities than those given above have been developed. Cramp (1925), while studying the velocities necessary to convey wheat and other grains, arrived at a formula of considerable intricacy. While his formula probably covers most of the essential variables involved in conveying, in view of difficulties inherent in their determination it is doubtful that it is more accurate than those already mentioned. As pointed out, it is not possible to foretell the exact conditions relating to the flow of solid materials in an air stream, and hence in the absence of such knowledge we cannot expect to predetermine the relative importance of the variables involved. Furthermore, most conveying systems are rarely if ever uniformly loaded. There are instances when heavy slugs of material are moved, while at others the concentration conveyed is a mere fraction. In fact, for materials such as grain and granular cellulose, the simple empirical rule of 25 pounds bulk weight per 1000 cubic feet of air per minute (velocity 4000 feet per minute) is often sufficient.

Conveying Systems

Having indicated in preceding paragraphs the matters of fundamental importance to design, we may now proceed to outline the general theory pertaining to conveying systems themselves. These systems may be classed broadly into three types: open systems, semi-closed systems, and closed systems.

Open systems. Open systems are generally employed on farms for conveying ensilage and grain, and lumber scraps or shavings. In these systems the material is drawn under suction directly through the fan housing and conveyed under positive pressure to a suitable point of discharge. Open systems

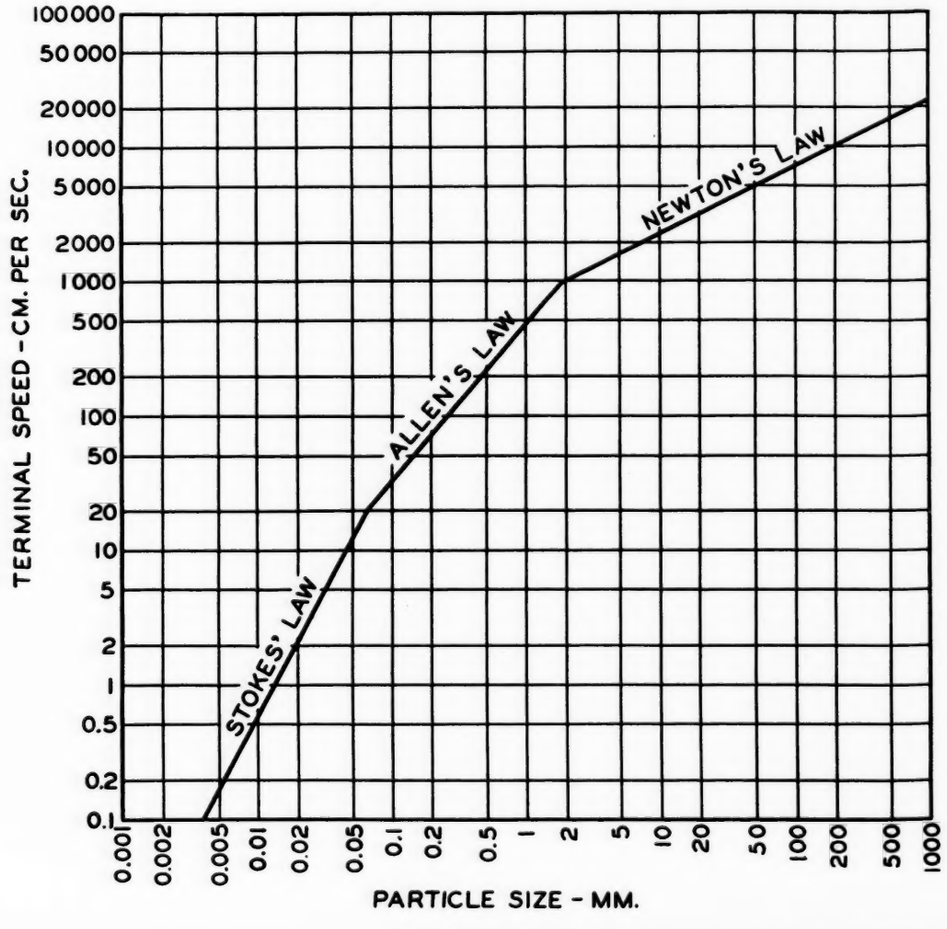


Fig. 2. Results of Martin on terminal velocities of crushed sand.

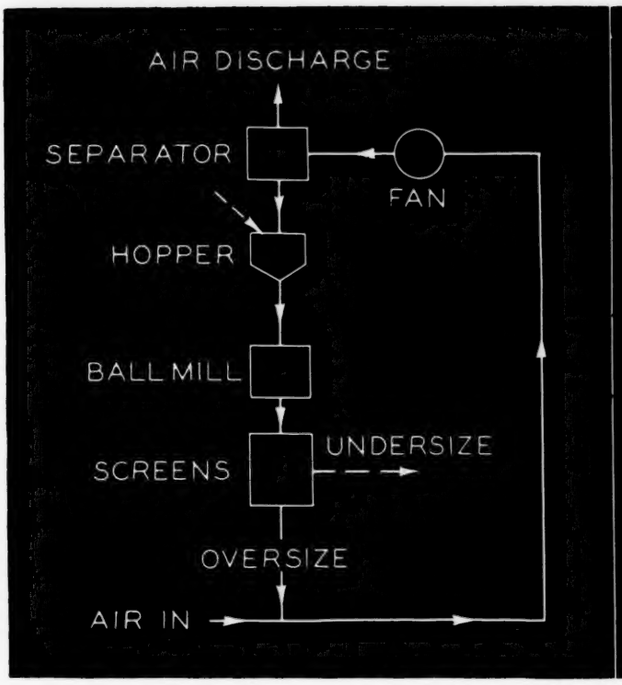


Fig. 3. Semi-closed system for ball mill grinder.

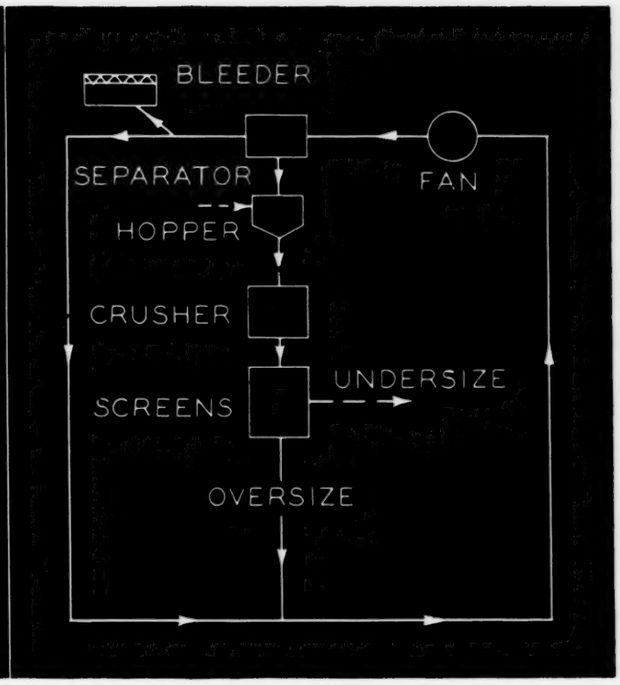


Fig. 4. Closed system for crusher installation.

can be employed only for conveying large material having a well-defined trajectory at discharge. It cannot be used for conveying fines unless such material is to be disposed of through a stack. Open systems require special fans whose paddles possess sufficient clearance to avoid clogging. They are the simplest type of conveying system in use.

Semi-closed systems. The second type, or semi-closed system, possesses two variations, and is suitable for practically all kinds of material. It consists of the necessary ducts, with a collector (filter bags or cyclone) placed at the discharge end, or at some point between the intake end and fan. The latter variation is preferable, although more efficient separation is obtained with a cyclone if placed under positive pressure. The semi-closed system is the most widely used form of conveying and separation, and forms the basis of all industrial dust collecting systems in use today. The use of separators prevents the loss of material and confines it to the point desired.

An interesting application of a semi-closed system is used in ball mill grinding. A typical system in this process is shown schematically in Figure 3. Here the air is blown directly through the mill at such a rate that all material below a specified size is removed and conveyed to a separator and screens. The oversize from the screens is then returned to the same or another ball mill for further crushing. This procedure improves the efficiency of grinding and helps to produce the size characteristics desired.

When conveying industrial materials it is preferable to separate them before they reach the fan. Cyclones are very effective for material larger than 150 mesh, but if the material is smaller the efficiency of collection decreases. Filter bags in air-tight housings are more efficient. Such filters should be equipped with automatic mechanical vibrators and should be so arranged that the filter units are cut off during shaking. The material collected may be retained in a hopper or conveyed to a nearby point by screw conveyors. Selection of the requisite amount of filter area is always of some concern. Rates as high as 10 cubic feet per minute per square foot of cloth are not uncommon, although lower rates are generally preferable. Allowance should also be made for possible development of condensation in filters, especially if filters are located out-of-doors.

Closed systems. The third type of system has special application to crushing and grinding operations. This type of system is used in the forms shown in Fig. 4, and as the name implies is actually closed. Material leaving the crusher is fed to screens, and that passing them is assumed to be of proper size. The oversize is returned to the duct system, thence to the separator, and back into the crusher. Air leaving the fan then returns to the lowest point of the system to pick up the rejects. The bleeder indicated in the figure serves as an escape for the excess air drawn into the system through the enclosed screens and other openings. Closed systems are used only where for reasons of space it is not possible to use a "perfect" separator. It is adapted to such separators as Roto-clones and cyclones, or where air temperature is a primary consideration. Otherwise, the semi-closed system is preferable.

The size and location of the bleeder is difficult to predetermine. Since the system is closed, there is

a point of null pressure within it. If this can be determined, it would seem best to locate the bleeder as near that point as possible; otherwise, it is preferable to have it at under positive pressure. The sieves should be located so as to be under negative pressure. If the concentration of fines is high, these will constantly circulate about the system and it is possible that the bleeder (which is merely an outlet with a small filter) will clog and fail to function. The accumulation of fines may seriously handicap the system, although as their concentration increases they should be more easily separated, and there is presumably a theoretical upper limit of concentration they can attain. Nevertheless, if there is an inward leakage of air on the negative side of the fan (say through the screens) and this excess cannot escape, the null point must obviously shift until the openings in the screen housings act as bleeders momentarily. Thereafter the null point will remain fixed. A bleeder located near the theoretical null point of a closed system permits air to blow in or out in small amounts sufficient to keep the system in equilibrium.

Energy Losses

It has been demonstrated fairly well that in hydraulic conveying the loss in head in a given duct is almost the same as though the fluid alone were flowing in the same duct. This is approximately true for air, provided the concentration of material conveyed is not very great, say 100 grains per cubic foot at a bulk density of 25 pounds per cubic foot. At higher concentrations the resistance to flow increases, due to constriction and roughness of particle surfaces. A fair estimate of the drop is possible in the usual friction formulas by either of two methods: (a) by assuming the density of the air to be that of air plus material suspended, or (b) by increasing the friction coefficient (Fanning's coefficient). Since the latter cannot be estimated and since no data are available, the former procedure seems best. As an example, assume that 200 grains of a given material are conveyed at a velocity of 4000 feet per minute, the air density being .075 pounds per cubic foot (375 grains). Neglecting the volume of material which is generally small, we therefore must consider an arbitrary density of $200 + 375 = 575$ grains per cubic foot in calculating resistance.

As for elbows and transitions where the nature of particulate flow cannot be determined, it is best to utilize resistances twice as great as those for air alone.

Some pneumatic conveying systems are of considerable length and are composed of pipe having relatively small diameter. This is true of systems used to unload shipments of material from ship holds and freight cars. The intake end must be handled by a workman and consists of flexible tubing. Also the nozzle must be carefully designed to possess the velocity characteristics required to pick up the material, and for this reason may be slightly smaller than the flexible tubing itself. For these reasons, the losses incurred in the system may be enormous and may amount to several inches of mercury. However, in spite of this common characteristic, it must not be assumed that high vacuum systems possess any special attributes for conveying or are to be compared with those operating with a few inches pressure drop measured on a water gauge. The conveyed material moves by virtue of the air velocity imposed upon it, and is not to be regarded as a fluid or even plastic material inherently subject to pressure changes.

Economics

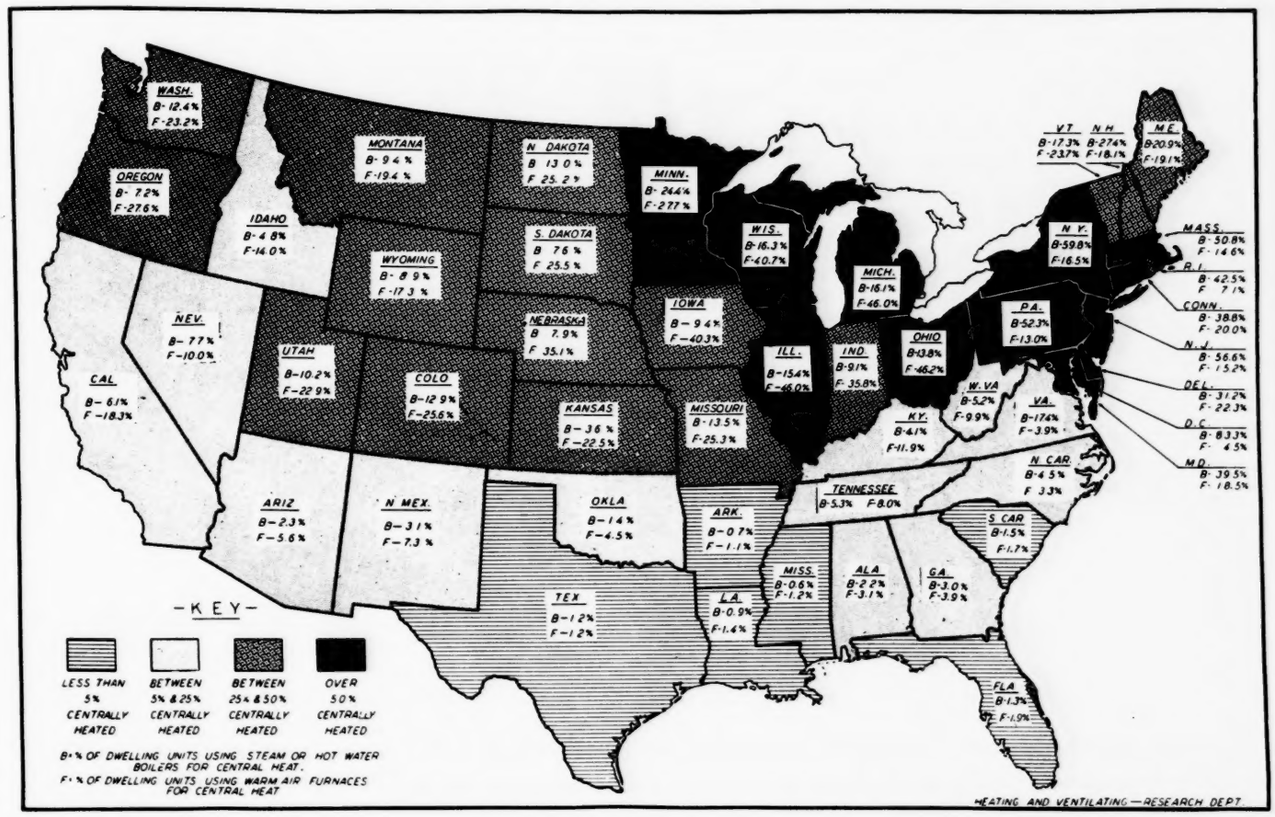
The economics of pneumatic conveying is unfortunately not well understood. This type of conveying is but *one* of many. It has unusual advantages in handling certain materials under special conditions. Often it can be troublesome and actually ineffective. Careful thought should be given to the properties of the material to be conveyed before cost figures are compiled.

As to the final selection of a suitable conveying method, we should consider the following items and compare them for each method under study:

(1) Adaptability of method to situation at hand;
(2) First cost of installation;
(3) Maintenance cost for repairs;
(4) Cost of operation, either annual or on ton basis; and
(5) Cost of material lost.

It should be remembered that while pneumatic conveying is convenient, it is not necessarily compact, especially if filters are provided. On the other hand, it is an efficient method of conveying since loss of material is kept at a minimum. Repair costs on a ton-of-material-conveyed basis are probably no higher than other methods of conveying unless duct work must be broken into at frequent intervals to remove clogged material. Operation costs on a ton basis are probably higher than for other conveying techniques, since so much energy is used to overcome air friction in the duct line, and relatively little is needed to keep the material in motion and to deliver it to the point of disposal.

It is possible that frequent industrial failures with pneumatic conveying systems have discouraged their wider adoption in scores of processes. This may be attributed to the lack of published data and experience with these systems. However, such systems are inherently simple and can be made to operate for many particulate substances. Perhaps, too, lack of interest in pneumatic conveying systems arises from failure to stress their advantages which thus remain unknown to industrial engineers. Certainly there are many instances where this method of conveying has proved its worth and it consequently deserves attention and wider application.



Relative concentrations of central heating in U. S. dwelling units according to 1942 census.

How U. S. Houses Are Heated

By GEORGE LITTLEWOOD

Research Dept., HEATING AND VENTILATING

FROM data made available by the 1940 Census, the house-heating market is far from saturated, for 58% of all dwelling units in the U. S. are still without central heating. Furthermore, even in the cold and relatively wealthy Middle Atlantic States over 28% of all dwelling units are not centrally-heated, and in the still colder New England and East North Central districts over 40% of the dwelling units have no central heating plant.

The 1940 Census produced a wealth of statistical information on various phases of housing, including those on type of heating plant and fuel for heating. Those data pertinent to heating are summarized in Tables 1 and 2, in which the percentages are the ratio to the state total.[1]

[1]These tables are condensed from similar but far more complete tables broken down by states as well as regions, and with percentages as ratios of the U. S. total not included here. These more complete tables are available without charge to interested marketing executives by writing Research Department, HEATING AND VENTILATING, 148 Lafayette St., New York, and requesting H&V Market Data Sheets Nos. 46A and 46B.

TABLE 1.—TYPE OF CENTRAL HEATING IN U. S. DWELLING UNITS

Region	Steam or Hot Water		Warm Air		Total Central Heat		No Central Heat	
	No.	%	No.	%	No.	%	No.	%
New England	905,452	41.8	347,718	16.1	1,253,170	57.9	911,649	42.1
Middle Atlantic	4,054,034	56.7	1,077,429	15.0	5,131,463	71.7	2,013,701	28.3
South Atlantic	544,091	13.1	245,980	5.9	790,071	19.0	3,380,562	81.0
E. North Central	1,036,422	14.4	3,174,423	44.2	4,210,845	58.6	2,982,881	41.4
E. South Central	82,225	3.2	165,576	6.4	247,801	9.6	2,307,136	90.4
W. North Central	461,682	12.7	1,062,349	29.3	1,524,031	42.0	2,114,594	58.0
W. South Central	36,469	1.1	59,637	1.9	96,106	3.0	3,153,705	97.0
Mountain	90,462	8.3	192,095	17.5	282,557	25.8	810,658	74.2
Pacific	214,007	7.3	593,582	20.2	807,589	27.5	2,125,851	72.5
Total	7,424,844	21.8	6,918,789	20.2	14,343,633	42.0	19,800,737	58.0

TABLE 2.—NUMBER AND PERCENT OF DWELLING UNITS USING VARIOUS FUELS

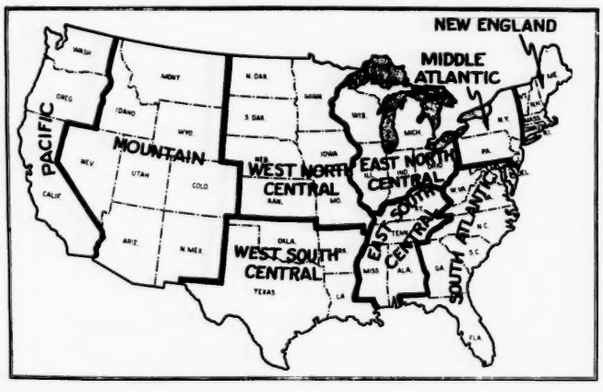
Region	Centrally-Heated								Not Centrally Heated	
	Coal or Coke		Gas		Fuel Oil		Other or No Report			
	No.	%	No.	%	No.	%	No.	%	No.	%
New England	828,873	38.2	15,348	0.7	325,603	15.1	83,346	3.9	911,649	42.1
Middle Atlantic	4,116,760	53.5	126,057	1.8	740,403	10.3	148,243	2.1	2,013,701	28.3
South Atlantic	550,029	13.2	52,886	1.3	1,662,234	4.0	20,922	0.5	3,380,562	81.0
E. North Central ...	3,781,264	52.7	159,797	2.2	150,872	2.1	118,912	1.6	2,982,881	41.4
E. South Central ...	210,903	8.2	26,368	1.0	2,284	0.1	8,246	0.3	2,307,136	90.4
W. North Central ..	1,129,331	31.0	153,940	4.3	137,030	3.8	103,730	2.9	2,114,594	58.0
W. South Central ..	9,077	0.3	72,855	2.2	5,460	0.2	8,714	0.3	3,153,705	97.0
Mountain	187,868	17.2	72,170	6.6	10,189	0.9	12,330	1.1	810,658	74.2
Pacific	86,081	2.9	429,468	14.6	149,516	5.1	142,524	4.9	2,125,851	72.5
Total	10,900,186	32.0	1,108,889	3.2	1,687,591	4.9	646,967	1.9	19,800,737	58.0

For the manufacturer of central heating equipment these statistics would seem to foretell a post-war market of some magnitude, since there are at the present time 19,800,000 dwelling units in the United States without central heat. To this potential market may be added a fairly large percentage of the now existing central heating plants which, because of the current period of restriction of goods for civilian consumption, will require replacement and remodernization.

Radiator heating is to be found in 21.8% and warm air in 20.2% of U. S. dwelling units. A dwelling unit is the space occupied by a family unit, so that in the case of a single-family house the term dwelling unit is synonymous with structures. However, this is not the case with flats or apartments, where one structure contains two or more dwelling units. In other words, central heating data can be misinterpreted if this distinction is not kept in mind, for while a 40-unit steam-heated apartment is 40 dwelling units it has only one heating system. Note, then, that all of *the accompanying data are on a dwelling unit and not on a structure basis.*

Radiator heat has been widely adopted in the Middle Atlantic and New England states where 56.7 and 41.8%, respectively, of the dwelling units are so heated (see Table 1). In the District of Columbia 83.3% of dwelling units have radiator heat, followed by New York state with 59.8% and New Jersey with 56.6% of its units so heated.

Warm air heating is relatively most popular in the East North Central, West North Central and Pacific region, where 44.2, 29.3, and 20.2% of the dwelling units are heated by furnaces. By states, warm air leads in Ohio (46.2%), Illinois and Michigan (both 46%).



U. S. zones referred to in tables.

When the radiator heat and warm air figures are totaled, giving total central heat installations, the Middle Atlantic region leads, with 71.7% of its dwelling units having central heating. Next, on this basis, are the East North Central and New England states, with 58.6% and 57.9%, respectively. By states, the District of Columbia is relatively most progressive, with 87.8% of its dwelling units centrally heated, followed by New York (76.3%) and New Jersey (71.8%).

The West South Central region has the greatest proportion of non-centrally-heated dwelling units (97.0%), although the East South Central district ranks high with 90.4%. Mississippi (98.2%), Arkansas (98.2%), and Louisiana (97.7%) are the states with the largest ratio of non-central-heat dwelling units.

Coal (and coke) is the most widely used fuel for dwelling unit heating in all districts except the Pacific and West South Central, where gas leads (see Table 2). Oil is very popular relatively in the New England and Middle Atlantic States. Fuels other than coal, coke, gas or oil are relatively most popular in the Pacific and New England states, where wood is an important fuel.

On a state basis the leading coal states (in percent of that state's total dwelling units) are New York, Pennsylvania and District of Columbia, in that order. High ranking gas states are California, Montana, and Wyoming. In this connection, Texas and Oklahoma rank low as gas-burning states because they rate low in central heating. Leading oil-burning states are District of Columbia, Connecticut and Maryland.

Such data as these from the 1940 Census indicate that in the post-war period when metals are again plentiful there will be a large market for central heating and automatic heating. Whether this market can be profitably tapped is another story, but the figures themselves, even when allowance is made for Southern houses, are encouraging.

WHAT THE AIR CONDITIONING ENGINEER SHOULD KNOW ABOUT LIGHTING

HEATING AND VENTILATING'S REFERENCE SECTION

LIGHTING AND AIR CONDITIONING

By HOWARD M. SHARP

Manager, Lighting Bureau
Buffalo, Niagara & Eastern Power Corporation

The urgencies of war are hastening the revolution begun in the 30's in architectural practice and in the materials and techniques of construction of buildings devoted to the activities of mankind. This is particularly true in the work world of office and factory. The control of light, temperature, humidity, air movement, and sound are factors of increasing importance. Some of these may be accomplished by the judicious control of natural forces, others by the intervention of mechanical forces. In some instances all five must be correlated, in others only one or more need be considered. In every structure provided for man's use lighting, however, is a necessity, and to an increasing extent lighting by artificial means. Air conditioning, involving all or part of temperature control, humidity correction and air movement is rapidly expanding. Therefore, these two important contributions to a more healthful, pleasing, and productive indoor world require coordinated planning if each is to perform its maximum function.

To this end, there is presented in the following pages those elements of lighting design which are important to the Air Conditioning engineer. The treatment of the subject is different from that usually encountered, and much new material is introduced. Of particular interest should be the discussions on the psychology of color, the relationship between lighting and radiant heat, and the method of analysis by means of which air conditioning costs and lighting costs can be balanced.

NATURE OF GOOD LIGHTING

In the natural environment wherein mankind developed he was bombarded by radiant energy, as a result of which through the patient march of time he developed responses to those portions of that energy which were important to his survival. The energy identified as heat is felt over the entire skin envelope of the body, but most acutely on the backs of the hands, the forehead, face, and feet. Nerve endings embedded in the skin react to energy through absorption, and by electro-chemical reactions, convey the stimulus to the cerebrum.

In the case of light, a more highly developed evolutionary process has resulted in the localizing of the response to radiant energy in the two eyes. In them, the energy is transformed and again by electro-chemical reactions the stimulus is transmitted to the cerebrum over specialized nerve channels—the optic nerves. Thus it is that lighting and air conditioning have a physiological basis for close partnership.

But the similarity does not stop there. As a result of the stimuli sent to the brain by those watchers of man's environment, the skin and the eyes, metabolism, blood pressure, muscle tension, and mental reactions are altered so as to affect that all inclusive, hard to define, but nevertheless important human reaction known as comfort. The engineer, be he interested in air conditioning or lighting, must never forget that his specialty vitally affects man in ways that are not subject to formulae, mechanical laws, or the sweet reasonableness of facts.

Just as the air conditioning engineer must maintain a nice balance between temperature, humidity, air change and air motion, so must the lighting engineer balance quantity of light, distribution of brightness, brightness contrast, shadow, diffusion and color. In approaching the design of a lighting system the ideal is to secure a result which will be in harmony with the basic use of the interior. Thus the aim may be for beauty, for the sale of merchandise, or the production of goods. The usual connotation of efficiency has no place in a lighting discussion. The most "efficient" light source, or the most "efficient" control surfaces, may produce an effect so out of harmony with the basic requirements of the area as to nullify the whole purpose of it. Obviously then, the sources and the controls so used would not be truly efficient because their use does not permit the maximum result. Once the lighting requirements have been determined, however, then the most efficient components should be used, providing their use does not violate the basic requirements. Thus if indirect lighting is indicated, use the most efficient indirect lighting; if direct lighting is called for, use the most efficient direct lighting system, always being alert for deviations which may improve the "efficiency" but lower the effectiveness. It is quite understandable that the air conditioning engineer is desirous of having as few watts as possible, but this desire should not reach to the point of withholding from the consumer the lighting results he expects, needs, and to which he is entitled.

In the material that follows there will be no attempt to force details of illuminating engineering upon the air conditioning engineer, but rather to furnish only that which will provide, so to speak, a philosophical understanding of adequate lighting requirements. This will be sufficient for the air conditioning engineer to assure his client that his present system is adequate or inadequate,

and if inadequate to anticipate future changes in lighting which will affect his air conditioning design, or to take the initiative in suggesting lighting changes before air conditioning plans are completed.

Lighting systems have two broad criteria of judgment: quantity of light delivered to the work point, and the quality of that light. It is not necessary to make a differentiation of importance between them; they are concomitant considerations with emphasis shifting from one to the other as conditions require. Quantity will be discussed first because it is simpler. The unit of measurement, the foot candle, is for all practical purposes equivalent to the amount of light shed on a surface one foot square held vertically one foot away from an ordinary candle. Full summer sunshine measures above 8000 foot candles; well lighted interiors rarely measure up to 100 foot candles; moonlight .02 foot candles. The amount of illumination determines the brightness of the object looked at and, within limits, the higher the brightness of a given object and its general surroundings the easier it is to see that object. Because human experience is conditioned by the huge amounts of outdoor illumination the trend of indoor illumination is ever upward. The illuminating engineer is in the unique position of being hard pressed to provide as much of the proper illumination as the client would like to have. Hence, there are rapid changes in the lighting art which make increasingly severe demands upon the air conditioning engineer. Of necessity, therefore, he must keep alert to such progress in order to properly serve his client.

Because quantity can be measured quickly by portable photometers it is one of the specific elements of illumination which can be specified and measured, hence a widely used criterion. However, no great skill is required to simply specify and supply amounts of light. The necessary accompanying quality encompasses most of the art and science of illumination. For this reason good engineering advice should be enlisted because knowledge and experience provide the synthesizing elements out of which satisfactory illumination is prescribed.

To attempt to give more than a brief exposition of lighting quality would involve a resume of most of the whole literature of the art. The air conditioning engineer needs only to know that color of illumination, color of surroundings, shadow, glare, and direction of light are involved. If these combine to provide visual comfort, good visibility of the eye task and light when and where it is needed, the illumination design can be said to be good. A lighting system can be made up of the most efficient components and yet produce glare or shadows to such an extent as to hinder vision rather than aid it, even though the photometer might record a high reading. Or again a lighting system of high quality, that is with no glare, soft shadows and easy contrasts, may furnish an amount of illumination inadequate for the visual task at hand. Only competent lighting advice should be trusted to provide a sound answer.

Much of the air conditioning engineer's work involves areas in which lighting serves principally to provide decoration or atmosphere. This does not involve much light, but attention to color and extremely low brightnesses may require the illuminating engineer to literally throw away most of the luminous energy in order to achieve the necessary effect. This contributes to the heat load, and from a strictly engineering point of view may be wasteful and inefficient, but from the viewpoint of the client, quite efficient because it produces the result desired.

TERMINOLOGY OF LIGHTING

FOOT CANDLE:
A unit of measurement for quantity of light. The amount of luminous flux intercepted by a surface of one square foot every portion of which is one foot from a source of one standard candle.

DIRECT LIGHTING:
A system of lighting in which substantially all of the light from the source is directed to the plane of work. Widely used in factories. Fluorescent coffers are direct lighting devices but of such large area as to be in a special class.

DIRECT-INDIRECT LIGHTING:
A system of lighting in which approximately equal amounts of light are directed upward or sideward, and down to the plane of work. Used generally in stores but with caution in offices.

INDIRECT LIGHTING:
A system of lighting in which substantially all of the light is first directed toward the ceiling from which it is diffused throughout the area. Widely used in offices and drafting rooms, and in commercial establishments for atmosphere.

REFLECTION FACTOR:
The ratio in per cent of the light reflected from a surface to the light falling upon it. Not a measure of the color of a surface.

SENSIBLE HEAT AND LIGHTING

Any lighting system will produce heat which must be removed along with the other heat gains when air cooling is desired (see Table 1). The air conditioning engineer with his feet on the ground accepts this fact in the same way as he accepts the inevitable heat gain from human beings, solar radiation, and outside air. Unfortunately, certain commer-

TABLE 1 – RELATIVE VALUES OF VARIOUS HEAT GAINS IN PER CENT OF TOTAL COOLING LOAD

(From "Lighting & Air Conditioning Design Factors", Illuminating Engineering, September, 1941)

SOURCE OF HEAT GAIN	OFFICES	APPAREL STORES	DEPT. STORES	DRUG STORES	BEAUTY SHOPS	RESTAURANTS	SMALL SHOPS
LIGHTING	17%	24%	24%	12%	9%	9%	19%
SOLAR RADIATION THROUGH WINDOWS	16%	6%	7%	0	3%	2%	4%
CONDUCTED HEAT	17%	26%	15%	23%	26%	12%	28%
OCCUPANTS	14%	18%	20%	32%	15%	26%	14%
OUTSIDE AIR	26%	22%	28%	23%	15%	29%	25%
MISCELLANEOUS	10%	4%	6%	9%	33%	22%	8%

TABLE 2 - EFFECT OF LIGHTING ON AIR TEMPERATURES

(From tests on a two window office, 300 sq ft in area as derived from Heating Effect of Air Conditioning Systems by Carrier and Walker (A.S.H.V.E. Trans., January 1918)

LIGHTING INTENSITY WATTS PER SQ FT	TEMPERATURE RISE, F.	
	WINDOWS AND TRANSOM OPEN	ALL OPENINGS CLOSED
2	5	1.5
4	1	3
6	1.25	4.5
8	1.8	6
10	2.25	7.5
12	2.6	9
14	3.1	10.5
16	3.5	12
18	4	13.5
20	4.3	15

cial practices in both the lighting and air conditioning industries combine with psychological and physiological reactions of the human being to confuse the problem with that of comfort, and thus open the way to a great deal of confusion and misunderstanding. Comfort is a subjective sensation, and difficult to appraise. If a person is uncomfortably warm and the reason is obscure, the sensation is almost invariably assigned to some obvious condition and inasmuch as the lighting of a space is very much in evidence, and everyone knows that light sources are hot to the touch, the association of the lighting with the discomfort is immediate. Both the air conditioning engineer and the illuminating engineer must cope with this situation, hence the necessity for a careful analysis of just how lighting does affect air conditioning design and human comfort.

There are three main avenues of approach; sensible heat, radiant heat, and psychology.

A kilowatt of electric lighting produces 3415 Btu per hour, no matter what the light source may be. The effect these Btu from a lighting system have on the air temperature of an interior has been carefully explored and recorded. Table 2 summarizes the findings.

The tests upon which the data in Table 2 were based were conducted in the summer in a small office, 17 x 17 ft with a 12 ft ceiling. The structure in which the office was located had concrete floors and ceilings, tile partitions, and brick and tile exterior walls. Ventilation was simply that of nature, secured by raising the lower sash of the two windows and opening the transom over the door. It can be seen that for any loading in watts per square foot likely to be encountered in lighting practice (see Table 3), the rise in temperature would be a negligible factor in discomfort.

Mathematically the temperature rise for a closed interior, due to a lighting system, can be theoretically determined in a simple way. The temperature rise in an enclosed space in which the only air change is as a result of natural infiltration, that is, no doors or windows open but simply air leakage around them, can be calculated by this formula:

$$\text{Temperature Rise} = \frac{\text{Btu Input per Hour}}{1.08 \times \text{Volume of Space} \times \text{Rate of Air Change}}$$

Rate of air change is assumed as shown in Table 4.

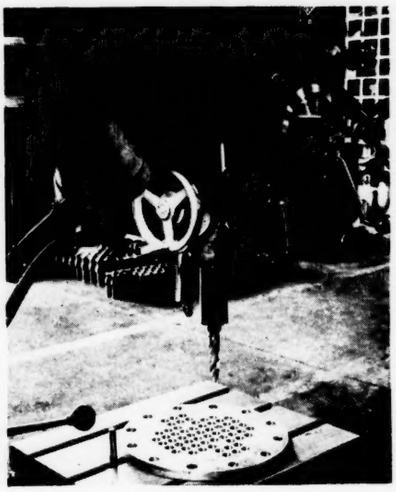
As an example, let us take the office in which the experiments summarized in Table 2 were run, with one outside wall, a door into a central hall, floor area 300 sq ft; ceiling height 12 ft and 1.2 kw of lighting. With all windows closed and the door and transom shut, the rate of air change is one per hour. The lighting system produces 4098 Btu per hour. The volume of the office is 3600 cu ft. Substituting in the formula, therefore, we have:

$$\text{Temperature rise in 1 hour} = \frac{4098}{1.08 \times 3600 \times 1} = 1.05\text{F}$$

The tests from which Table 2 was derived continued for seven hours, and the temperatures reported were the highest obtained. From the formula above, the office theoretically should have a 7F temperature rise at the end of seven hours but from Table 2, with a loading of 4 watts per square foot, the rise was only 3F. What happens, of course, is that as the temperature rises the rate of heat flow to the outside increases so that the heat gain is not cumulative in a straight line ratio.

This example is more or less extreme except that in the wintertime all openings may occasionally be tightly closed. Under normal conditions, with windows open slightly in winter and wide open in summer, the rate of air change in an office of this nature would be many times an hour with a negligible temperature accumulation. At a loading of 10 watts per sq ft, which is a situation rarely met with, natural ventilation removes heat at a rate which allowed a temperature rise of only 2.25F at the end of seven hours. At the present time advanced lighting practice with the more efficient fluorescent lamp indicates a loading of 6 watts per sq ft. From the evidence this would under usual conditions increase the temperature at occupant level only 1.25F, too slight a rise to be felt by those in the space. The author has conducted many similar tests under working conditions and has always found the results to be in close accord with the experiments reported. Therefore, on a basis of fact the effect of lighting systems on sensible heat and temperature, and resulting influence on comfort is not such as to warrant its consideration as a major problem.

While this conclusion may seem contradictory to the evidence presented in Table 1, in which lighting is shown to sometimes account for 25% of the heat load, a little thought will show that it is not. It is important to develop a clear distinction between the quantity known as heat gain, and the subjective sensations known as comfort or discomfort. It does not follow that large heat gain means much discomfort or that little heat gain spells comfort. Recall that a 3F change in effective temperature is necessary to produce a reportable change in comfort sensation. It could be that all of this 3F change would be available as a safety factor in a given situation. This would mean a considerable leeway in air temperature change, within which a lighting system of considerable power could operate without being felt. On the other hand, environmental conditions could be such that only a slight increase in heat input and temperature rise would shift all sensations from comfort to discomfort, and the same lighting would be the recipient of adverse comments. The heating and ventilating engineer establishes a temperature differential between indoor and outdoor conditions. If he is interested in air cooling, any heat which operates to reduce this differential is called a heat gain, but the ratio which a particular heat gain holds to the total heat gain cannot be taken as the measure of its relative effect upon comfort. For example, solar radiation through windows in offices, from Table 1, is equal to lighting as a source of heat gain but to a worker next to a window the effect of that



Filament sources are used for supplementary lighting where the equipment must be small and the light carefully controlled. Radiant heat will be felt but, due to intermittent exposure by the worker, no problem is created.

TABLE 3 – PROBABLE THERMAL EFFECTS OF LIGHTING INTENSITY FOR VARIOUS TYPES OF COMMERCIAL AND INDUSTRIAL ESTABLISHMENTS

TYPE OF ESTABLISHMENT	FOOT CANDLES	FLUORESCENT		MERCURY		FILAMENT	
		WATTS PER SQ. FT.	SENSIBLE HEAT EFFECT, F. (a)	WATTS PER SQ. FT.	SENSIBLE HEAT EFFECT, F. (a)	WATTS PER SQ. FT.	SENSIBLE HEAT EFFECT, F. (a)
OFFICES							
BOOKKEEPING AND STENOGRAPHIC	50	4	1	–	–	8	1.8
BUSINESS MACHINES * †	100	–	–	–	–	–	–
DESK WORK - INTERMITTENT	25	2	15	–	–	4	1
DESK WORK - PROLONGED	50	4	1	–	–	8	1.8
DRAFTING	50	4	1	–	–	8	1.8
CONFERENCE ROOM	25	2	.5	–	–	5	1
FILING AND INDEXING	25	2	.5	–	–	5	1
MACHINE SHOP							
AIRPLANE STOCK PARTS	50	3.5	1	–	–	7	1.8
TOOL MANUFACTURING	50	3.5	1	3	1	7	1.8
AIRPLANE INSPECTION * †	100	–	–	–	–	–	–
AIRPLANE METAL SHAPING	50	3.5	1	–	–	7	1.8
AIRPLANE ASSEMBLY	30	2	.5	2	.5	4	1
ARTILLERY ASSEMBLY	50	3.5	1	3	1	7	1.8
ARTILLERY MANUFACTURING	30	2	.5	2	.5	4	1
GAUGE ROOMS	50	3.5	1	–	–	7	1.8
PRECISION ASSEMBLY OF RANGE FINDERS, GUN SIGHTS, TORPEDO MECHANISMS * †	100	–	–	–	–	–	–
SHELL MANUFACTURING AND ASSEMBLY	50	3.5	1	3	–	7	1.8
CANDY MAKING	30	2	5	–	–	5	1
TEXTILE MILLS							
COTTON SPINNING	20	1.25	.5	–	–	3	1
GREY GOODS INSPECTION	50	3.5	1	–	–	7	1.8
WEAVING	25	1.75	.5	–	–	4	1
SILK AND RAYON							
WINDING	30	2	.5	–	–	5	1
WARPING	50	3.5	1	–	–	7	1.8
WOOLENS							
LIGHT GOODS WEAVING	25	1.75	.5	–	–	4	1
DARK GOODS WEAVING	50	3.5	1	–	–	8	1.8
MERCANTILE ESTABLISHMENTS * *							
RESTAURANTS	5	1 – 2	.5	–	–	5	1
DRUG STORES	20	1.5	.5	–	–	3	1
VARIETY STORES	30	2	.5	–	–	5	1
DEPARTMENT STORES	20	1.5	.5	–	–	3	1
WOMEN'S APPAREL	20	1.5	.5	–	–	3	1
MEN'S APPAREL	30	2	.5	–	–	5	1

* THESE AMOUNTS OF LIGHT ARE USUALLY PROVIDED BY LOCAL, INDIVIDUAL REFLECTORS. NO LOADING IN WATTS PER SQUARE FOOT CAN BE SAFELY PREDICTED.

** FOOT CANDLES IN COMMERCIAL ESTABLISHMENTS ARE DETERMINED BY SO MANY FACTORS OTHER THAN VISUAL REQUIREMENTS THAT THESE FIGURES ARE ONLY TO INDICATE GENERAL TRENDS. COMPETITION MAKES RAPID CHANGES IN LIGHTING NECESSARY AND AIR CONDITIONING DESIGNERS SHOULD KEEP THIS FACTOR IN MIND.

† THE RADIANT HEAT EFFECT, NO AIR CONDITIONING, IS PERCEPTIBLE IF FILAMENT, NOT IF FLUORESCENT.

(a) WITH NO AIR CONDITIONING, PERCEPTIBLE RADIANT HEAT IS "NONE" EXCEPT FOR CASES MARKED (†).

TABLE 4 - RECOMMENDED RATES OF AIR CHANGE

(From Comfort Air Conditioning Standards, Western New York Chapter, ASHVE)

TYPE OF SPACE	AIR CHANGES PER HOUR
OFFICE, 1 SIDE EXPOSED	1
OFFICE, 2 SIDES EXPOSED	1½
OFFICE, 3 SIDES EXPOSED	2
OFFICES, NO WINDOWS OR OUTSIDE DOORS	¾
DRUG AND CIGAR STORES	2½
OTHER RETAIL STORES	1
RESTAURANTS	2½
CHURCHES	1½
THEATERS	1½
ASSEMBLY HALLS	1½

heat gain upon comfort is many times greater than the effect of heat gain from the lights. Or let us consider the department store in which occupants account for 20% of the heat gain. If there were no occupants in the store at all the air cooling system would be loafing and, although lighting would then be 40% of the heat gain, there would be no question of comfort, because design conditions were being easily met. Let the store be filled to overflowing, however, so that the factor of safety between comfort and discomfort becomes very small and a small change in the thermal environment such as occasioned by turning out a portion of the lights may produce large changes in sensation, with the lighting taking all the credit for the change.

It is commonly assumed that all of the energy dissipated by a light source has an effect upon the thermal situation of the interior. From the standpoint of theory as well as practice this is rarely true. From a study of Table 5 it is seen that a bare filament lamp of the 300-500-watt size, for example, dissipates 19% of its energy in immediate sensible form, that is to the surrounding air, and 81% in radiant form. This radiant energy must be absorbed and re-radiated before it can affect the air temperature. Some of it will be transformed by whatever light control device is used. Some will pass out the windows and be lost; a portion will be absorbed by the clothing of people and be carried away; the rest will be absorbed by walls, floor, ceiling and furniture. Since no room is a perfect heat trap some of that will filter out into other areas or the outdoors.

The high pressure mercury lamp dissipates 62% of its energy in radiant form and 38% in sensible form. The watts lost in the ballast are dissipated in sensible form so if the ballast is in the occupied area about 45% of the combined lamp and ballast wattage is in sensible form and immediately available for raising air temperature. Likewise, a bare 40-watt fluorescent lamp dissipates 54% in immediate sensible form and 46% in radiant form. The watts lost in the ballast are dissipated as sensible heat so that if the ballast is in the room about 60% of the combined fluorescent lamp and ballast wattage is in sensible form. It can be seen, therefore, that on a basis of equal watts a fluorescent lamp or a mercury lamp could have a more deleterious effect upon sensible heat contribution than a filament lamp. Practically, however, such a discussion is of little value outside the laboratory because the variables in the entire comfort problem are far greater than these. In short, it is not necessary to pay any more attention to lighting as a factor in heat gain than to any of the other six components. The engineer is always charged with the responsibility of achieving a desired end with the maximum of effectiveness at the least cost. The conscientious one will give due weight to all factors and design accordingly, giving little heed to the urgings of those who are interested only in commercial exploitation.

If lighting has no undue influence on sensible heat and its concomitant comfort sensation there still remains the question as to why it seems so easy to ascribe sensations of discomfort to a lighting system. Let us explore the radiant heat situation to see if it offers a solution.

LIGHTING AND RADIANT HEAT

The influence of radiant heat upon sensations of comfort and discomfort is still not well understood. It has been established that a degree of M.R.T. (Mean Radiant Temperature) is about as effective in influencing comfort as one-half degree of effective temperature.* This means that inasmuch as 3F effective temperature change is required to produce an awareness of change in physical well being, a 6F change in M.R.T. will be necessary for the same effect.

It is also known that the threshold of sensation for radiant energy on the face or backs of the hands is 7F M.R.T. Of interest of course, is how much and what kind of lighting will be necessary to produce these conditions.

One approach has been from the standpoint of foot candles. Some-

*"Radiation as a Factor in the Sensations of Warmth," by Houghton, Guest and Suciu; American Society of Heating and Ventilating Engineers, 1941.

TABLE 5 - ENERGY DISTRIBUTION OF LIGHT SOURCES

	PER CENT SENSIBLE ENERGY	PER CENT RADIANT ENERGY	IF BALLAST IS IN CONDITIONED SPACE	IF BALLAST IS OUTSIDE OF CONDITIONED SPACE
300 - 500 WATT FILAMENT (BARE)	19 %	81 %	—	—
HIGH PRESSURE MERCURY (BARE)	38 % OF LAMP 100 % OF BALLAST	62 % OF LAMP	45 % TOTAL WATT ENERGY OF LAMP AND BALLAST IN SENSIBLE	38 % TOTAL WATT ENERGY OF LAMP AND BALLAST IN SENSIBLE
40 WATT FLUORESCENT (BARE)	54 % OF LAMP 100 % OF BALLAST	46 % OF LAMP	60 % TOTAL WATT ENERGY OF LAMP AND BALLAST IN SENSIBLE	54 % TOTAL WATT ENERGY OF LAMP AND BALLAST IN SENSIBLE

TABLE 6 - MEAN RADIANT TEMPERATURES OF VARIOUS WORK PLACES

(Derived from data secured in connection with investigations leading to "Mean Radiant Temperatures of Lighting Systems with Comfort Correlations", by Howard M. Sharp; Illuminating Engineering, November, 1940.)

TYPE OF WORK PLACE	LIGHTING SYSTEM	WATTS PER SQUARE FOOT	HORIZONTAL FOOT-CANDLES UNDER LIGHTS	M.R.T. OF LIGHTING SYSTEM MEASURED UNDER UNIT	TOTAL M.R.T. OF WORK AREA
VARIETY STORE	ENCLOSING GLOBES	3.3	39	3.5	6.5
VARIETY STORE	DOWN LIGHTS	6.25	42	1.5	1.8
LARGE OFFICE	INDIRECT	3	18	1	1.2
DRAFTING ROOM	INDIRECT	5	30	3	3
MEDIUM OFFICE	INDIRECT	5	40	3	4
SMALL OFFICE	INDIRECT	4.5	24	1	1
DEPARTMENT STORE	INDIRECT	1.7	14	1	1.5
SMALL STORE	INDIRECT	4.5	10	1	1
FACTORY	DIRECT	4.3	39	1.5	1
FACTORY	DIRECT	2.65	64	3	2

where between 125 and 150 foot candles of filament lighting and 600 to 900 foot candles of fluorescent lighting produce a sensation of warmth.† These tests were made under direct lighting. The lower values are obtained when using low wattage lamps and the higher values with large lamps. This answers the question from the standpoint of foot candles. It will be a long time before general lighting of interiors approaches either of these levels with any light source. Therefore, radiant heat from general lighting systems can be dismissed as a factor in discomfort. It must be pointed out, however, that where supplementary lighting is used these thresholds will often be exceeded for filament lamps and that sensations of warmth will be felt at face or hands. Whether or not this will be an unpleasant sensation is subject to a number of conditions. To assume that all heat is uncomfortable is to deny the evidence.

Another approach has been to measure the total M.R.T. and the lighting M.R.T. in a number of typical commercial and industrial interiors, thus integrating a number of factors that would be missing in a laboratory but essential in a work world analysis. In Table 6 will be noted some results of those tests. In only one case does the total M.R.T. of the area approach the threshold of perception. It is interesting to speculate, however, on the finding that even though the lighting system contributes but one-half the total M.R.T., when the system is turned on some effect might be felt, and if the sensation was one of discomfort the lighting system would get *all* the blame. It is possible that this situation arises more often than is suspected and inasmuch as the lighting is the only obvious change in the environment, the sensation is assigned to it.

It will be noted that in the two factory areas the M.R.T. of the work place is less than the M.R.T. for the lighting system. The reason is that the walls, ceiling and floor were at lower temperatures than the air so that there was a negative M.R.T. for the structure itself. Under these circumstances the body radiates readily to the environment, and heat contributions from whatever source would be welcome. This condition prevails in many work areas during the colder months. In general, the heat output of factory workers is relatively high both summer and winter due to muscular activity, so that the range of sensation of comfort and discomfort is much broader than for persons engaged in sedentary occupations or pursuits. Inasmuch as most psychrometric data are based upon the latter situations it is inadvisable to extend these criteria into the more active work world. Unfortunately there is a tendency to do this on the part of many, with consequent increase in confusion over what is fact, and what is folklore.

The same situation applies to most homes. Due to the prevailing types of residential construction and the relatively exposed locations of most dwellings, during the cooler months the walls are generally at lower temperatures than the air in the room. The body radiates heat readily and to keep in equilibrium requires either higher air temperatures or additions of radiant heat. A little thought will thus explain the welcome of an open fireplace on a cold and windy night, or why it is that as winter progresses the thermostat needs notching up two or three degrees above normal for comfort when outside temperature goes down or winds increase.

The widely used 100-200-300-watt IES floor lamp produces at reading location about 2F of M.R.T., an amount well in advance of many commercial interiors, yet complaints of discomfort are practically non-existent. From the viewpoint of fact, therefore, the lighting of residential areas should not be inhibited by preoccupation with non-existent heat factors.

There is another aspect of the radiant heat factor which probably has little influence on present lighting practice but which may have a bearing on future trends, in both lighting and air conditioning. Progress in radiant heating, or panel heating, tends to bring the surfaces of walls, floor and ceilings to temperatures somewhat above that of the skin, thus retarding the radiation of body heat. Air temperatures may, therefore, be reduced with benefit to bodily health and the respiratory tract in particular.

The temperature of the ceiling and its effect upon the comfort of room occupants is probably of most importance to illuminating engineers. In the move toward higher foot candles the ceiling may well become almost solidly luminous, with light sources and redirecting or diffusing media creating a temperature sufficiently above average skin temperature to be considered as a source of radiant heat.

†"Cooler Footcandles," M. Luckiesh, *Magazine of Light*, Vol. VII, No. 8.

it might be asked if present lighting systems by contributing to the temperature of air near the ceiling do not perhaps approach a panel heating effect. To do so, this warm air would have to first raise the temperature of the ceiling itself. The extent to which this would be accomplished is influenced by so many factors that speculation is useless. In general, it appears that the temperature of ceiling air is not so much greater than air temperature at occupant level. Where ceilings are less than 20 feet in height it is common practice to calculate the ceiling air temperature as being greater than air temperature at breathing line by 2% for each foot of height above breathing line. A number of field measurements indicate that this formula includes enough of a safety factor to make unnecessary any allowance one way or the other for the contribution of a lighting system.

It can be concluded, therefore, that the influence of lighting on sensations of discomfort from sensible heat or radiant heat is either nonexistent, or of an order of magnitude that is so slight as to warrant no undue excitement. There remains the realm of psychology to be explored for possible color reaction.

COLOR INFLUENCE AND COMFORT

One long standing definition of colors has been to group them as cool or warm. Those of shorter wavelength, from green to violet, are known as cool; those of longer wavelength from yellow to red are known as warm. It would seem that long association with natural phenomena is responsible for this. Sunshine, with its heat and golden yellow color, and similarly fire, are experiences so universal and common that the association of yellow and red with heat is unquestioned. The shade of a tree provides relief from the sun, so another association is established, in which absence of obvious light sources spells comfort. Swimming in green or blue water provides relief from heat, and in the shade of buildings or at north windows the blue sky is visually important. Thus blue and green are noted as cool colors. White reflects visible radiation with its large heat component, and black does just the reverse. The clouds with their underside in shadow, and hence gray in appearance, cut off the radiant heat of the sun, and the association of coolness with gray, and lack of strong obvious light, is strengthened.

Thus there is abundant evidence that light which is predominantly yellow carries with it a connotation of heat, and that light which appears blue or white arouses an association of coolness. It is well known that the substitution of "daylight" bulb filament lamps for the ordinary filament lamp often causes complaints of heat to disappear even though the lighting wattage remains the same. Similarly, decorative schemes of yellows and reds in rooms devoid of sunshine, and greens and blues in rooms exposed to sunshine, seem more palatable to occupants.

In addition to the psychological aspects, there is speculation as to whether there might be a physiological reaction to color that would explain the classification of warm and cool. The ASHVE, in conjunction with the IES, conducted a preliminary experiment to determine whether eye exposure to red light caused constriction of blood vessels in the fingers with fall in temperature, a phenomenon associated with increasing metabolism, and whether exposure to blue caused dilation of blood vessels with increasing finger temperature, a phenomenon associated with decreasing metabolism. No association could be found between color of environment and the physiological manifestations of comfort or discomfort, nor could the purely subjective feelings of warmth be correlated. However, the experiments were conducted in an atmosphere of ideal comfort, and the experimenters in the report pointed out that if environmental conditions were at the borderline between comfort and discomfort, the changes in color *might* cause a shift from one sensation to the other. This supports the experience in the practical world of lighting and air conditioning in which a change in any one of the heat gains may shift the subjective reactions of people from comfort to discomfort, or vice versa, with consequent credit or blame for *all* of the previous condition being assigned to the one element changed.

LIGHT UTILIZATION

While the following statement may appear like over simplification, the major responsibility of the illuminating engineer is to see that his client receives the quantity and quality of light necessary for the task, in the most overall efficient manner, let the air conditioning figure out what it will. Although there is no occasion to whittle down the amount of light nor to resort to measures that are not in the customer's interest, there are many things to do to insure that the lighting system will contribute a minimum of heat load.

To repeat a statement made earlier, once the type of lighting system is determined, it should be made up of the most efficient components. There are then many things affecting the utilization of that light which the air conditioning engineer can emphasize. For example, light colored walls and ceilings make a considerable difference in the amount of light delivered to the working area. A fair sized store lighted with direct-indirect equipment, with white ceiling and light colored side walls will be 12% more efficient in light utilization than one with moderately dark ceilings and side walls, and 25% more effective than one with dark or dirty ceilings and side walls. If the above room were used for office purposes the best quality lighting would be indirect, in which case the percentage improvement would be very spectacular, being respectively 50% and 200%. Window shades and venetian blinds should be very light on the room side. Their contribution to lighting efficiently obviously depends upon the total wall area occupied, but it is safe to say that for areas within 8 ft of the windows double the illumination can be obtained over that to be expected from dark shades.

Another great improvement in lighting and seeing comes about through the use of floor coverings and furniture of light tones in the range of 20% to 30% reflection factor. While quantitative figures are lacking, the reduction in brightness contrasts improves visual comfort, and visibility, all of which makes for satisfaction with the lighting system with consequent smaller obsolescence factor. This means that the air conditioning system will *stay put* longer.

It is often possible to coordinate luminaire design with the removal of exhaust air. With coves, dropped ceilings, and extended trough-like luminaires, the air can scrub away much of the sensible heat. If the lighting design will allow the use of heat absorbing glasses which extract a high percentage of the radiant heat, converting it into sensible, the heat can be removed through ventilation either as part of the air conditioning system or separately. Commercial heat absorbing glasses, which *must* have a heat resisting base, intercept about 80% of the radiant energy with a loss of 25% of the visible energy. In colder climates this scrubbed heat can be reintroduced into the interior with

TABLE I: ANALYSIS OF LIGHTING SYSTEMS AS RELATED TO AIR CONDITIONING

SECTION A

PROPOSAL #1 | PROPOSAL #2 | PROPOSAL #3

1. LIGHTING UNIT
2. WATTAGE PER UNIT
3. LAMPS PER UNIT
4. RATED LAMP LIFE HOURS
5. INITIAL RATED OUTPUT PER LAMP
6. LAMP COST, EACH
7. LAMP RENEWAL COST FOR ALL FIXTURES
8. LUMINAIRE COST PER OUTLET, NET
9. TOTAL LUMINAIRE COST
10. WIRING COST
11. TOTAL INVESTMENT
12. WRITE-OFF 25% PER YEAR (RETIRED IN 4 YEARS)
13. BURNING HOURS PER YEAR
14. ANNUAL LAMP RENEWAL COST, NET
15. TOTAL LAMP RENEWAL COST AND WRITE-OFF, ITEM (12) + ITEM (14)
16. TOTAL WATTAGE OF ALL LAMPS AND AUXILIARIES
17. KW-HR PER YEAR (2000 HR)
18. ANNUAL ENERGY COST @ 2¢ PER KW HR (USE THE ACTUAL RATE THAT WOULD APPLY TO THIS LOAD)
19. TOTAL COST PER YEAR, ITEM (15) + ITEM (18)
20. AVERAGE FOOT CANDLES IN SERVICE
21. COST PER FOOT CANDLE YEAR

(CONTINUED IN SECTION B)

consequent reduction of heat input at the furnace. Lighting systems in which the luminaires are recessed in the ceiling offer many interesting possibilities for heat removal. This is particularly true of the fluorescent lamps which by their shape lend themselves admirably to this type of design and whose heat distribution, considering ballasts, is high on the sensible side, being 60% of total lamp and ballast watts.

Coordinating the choice or placement of luminaires with the flow of input air is highly desirable. In some instances it may be better to leave the upper layer of air undisturbed. In others the action of luminaires in changing direction of air flow has produced annoying and often mysterious drafts. Very definitely the lighting systems of the future are going to occupy a large percentage of the ceiling (up to 40%) either as extended elements, or recessed coffers, and careful planning is indicated.

Some interesting work has been done in the development of a paint which will absorb large amounts of radiant energy with small loss of visible energy.* For the present, work has been done only on a ceiling paint which has a slight greenish tint but reflects 75% of the visible light and only 30% of the total radiant energy. Of course, this absorption of radiant energy increases the temperature of the surface to which it is applied, but the paint is a poor re-radiator of the longer wavelengths, so the area in which it is used experiences little or no difficulty from high ceiling air temperatures.

Maintenance of a lighting system and the area in which it is used may not seem important to the air conditioning engineer but illuminating engineers know that a system in which burned out lamps are promptly replaced, reflecting and transmitting surfaces kept clean, and walls washed or repainted at suitable intervals, delivers more light longer, and thus insures stability of the area for which the air conditioning was designed. In addition to this factor, the well lighted, clean, well kept interior seems appropriate to the benefits conferred by air conditioning and thus adds to the user's satisfaction.

*"Minimizing Radiant Heat from Lighting Systems," IES Trans., July, 1939.

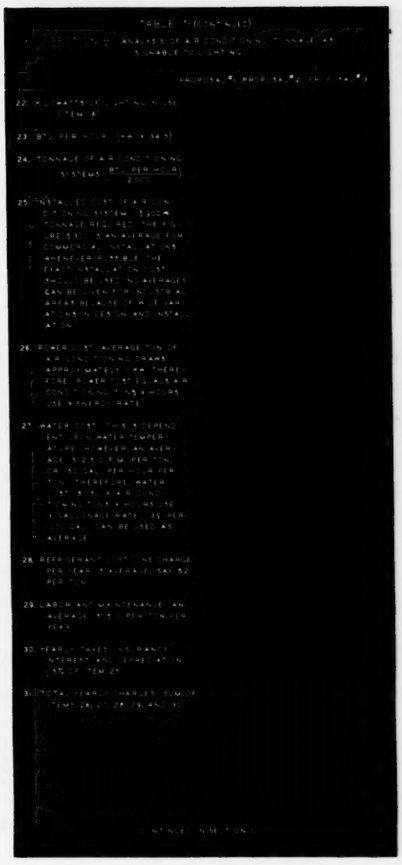


TABLE I (CONTINUED)

ANALYSIS OF A AIR CONDITIONING SUITABLE TO LIGHTING

PROPOSAL #1 | PROPOSAL #2 | PROPOSAL #3

22. KW WATTS OF LIGHTING USE ITEM 4
23. BTU PER HOUR (KW × 3413)
24. TONNAGE OF A R CONDITIONING SYSTEM BTU PER HOUR / 12000
25. INSTALLED COST OF A R CONDITIONING SYSTEM $1000 TONNAGE REQUIRED THE FIGURE $350 IS AN AVERAGE FOR COMMERCIAL INSTALLATIONS WHENEVER POSSIBLE THE EXACT INSTALLATION COST SHOULD BE USED AVERAGES CAN BE USED IN PRELIMINARY STUDIES BUT IN ALL CASES THE ACTUAL INSTALLATION COST SHOULD BE USED IN ANALYSIS
26. POWER COST AVERAGE TON OF A R CONDITIONING DRAWS APPROXIMATELY 1 KW THEREFORE 1 KW-HR PER TON EQUALS A R CONDITIONING HOURS USE ENERGY RATE
27. WATER COST THIS IS DEPENDENT ON LOCAL WATER TEMPERATURE AND IS HOWEVER AN AVERAGE OF $2.25 PER 1000 GAL THEREFORE WATER AT $2.25 PER 1000 GAL COOLING TOWER HOURS USE DRAINAGE RATE 35 PER CENT CAN BE USED AS AVERAGE
28. REFRIGERANT COST ONE CHARGE PER YEAR AVERAGE SAY $2 PER TON
29. LABOR AND MAINTENANCE AN AVERAGE $25 PER TON PER YEAR
30. YEARLY TAXES INSURANCE INTEREST AND DEPRECIATION 5% OF ITEM 21
31. TOTAL YEARLY CHARGES SUM OF ITEMS 28, 29 OR 29 AND 30

INTINUED IN SECTION C

ties for service difficulties. The fluorescent lamp being of large area does not lend itself kindly to accurate control but the mercury lamp is excellent in this respect. The color quality of each is far from what the public accepts as natural and with the fluorescent lamp particular care must be given to colors of the surrounding walls and furniture if harmony is to result. Mercury and fluorescent lamps deliver about two and a half times as much light per watt as filament sources, but fixtures cost three to five times as much.

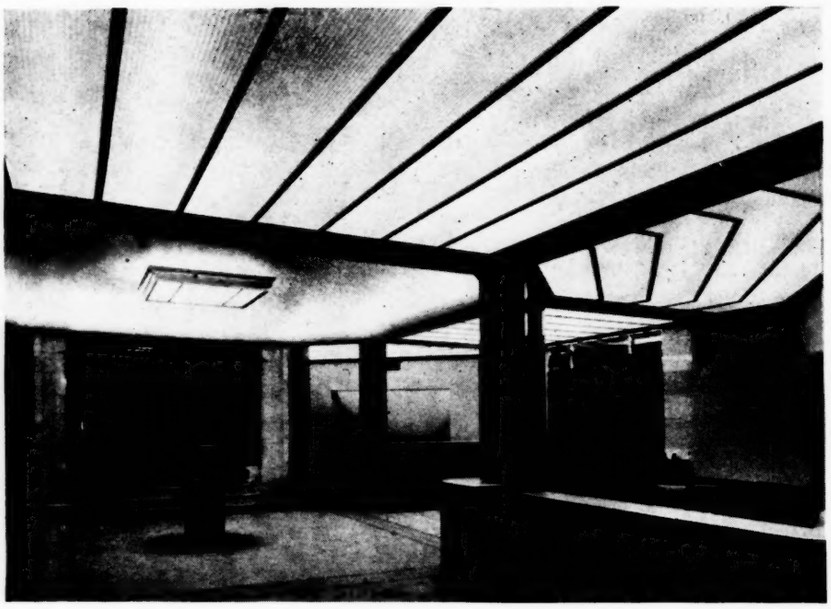
Now all these things are mentioned not disparagingly but to emphasize that the selection of any one is governed by knowledge of the lighting art and the skill of the practitioner. If these are lacking, the result can be distressing.

SELECTION OF LIGHT SOURCE

In the days when the universal light source was the filament lamp there was little or no selection problem. Now that the mercury vapor lamp and the fluorescent lamp have taken their place in the lighting industry, the wider choice of a source opens up wider avenues of speculation, claim and counter claim, and the air conditioning engineer will find himself to an increasing degree in the position of a Solomon. Therefore, a brief resume of essential characteristics may prove helpful.

The filament lamp is the most simple, fool-proof light source available. Its light can be admirably controlled, projected great distances and directed into asymmetric patterns. It operates directly on standard secondary voltages, utilizes simple equipment and is no mystery to the average user. It is cheap, and widely available. It is not as efficient as the mercury or fluorescent sources but the color of light produced is accepted as natural by the consuming public. Temperatures or drafts do not affect it.

Mercury and fluorescent sources are not so simple electrically. They require controlling ballasts and some fluorescent lamps need automatic starting switches. They are not so widely available nor are they cheap. They are sensitive to temperatures below 40F and above 100F, and drafts. The mechanical requirements of fixtures and the electrical circuit characteristics offer many possibili-



A lighting system such as this offers excellent opportunities for combining with air conditioning in a most efficient removal of sensible heat.

From the viewpoint of the coordination of lighting and air conditioning one of the most troublesome statements is that relating to the "coolness" of mercury vapor sources —particularly the fluorescent; troublesome because so many people know so much that isn't so. As has been pointed out, psychological coolness is an attribute of any visual sensation that leans toward the blue, or north sky light. The mercury sources possess this attribute, but there is no scientific evidence that will allow the designer to use this attribute in a quantitative way. Therefore, it cannot be used as a factor in air conditioning design.

When it comes to the heating effect of light sources, the advantages of the higher efficiency of the mercury sources are often obscured by lack of sound engineering, or the inclusion of strictly promotional elements. As has been pointed out, on a basis of *equal* watts, the mercury source may put more of a load on a cooling system than filament sources. This is emphasized, not to present it as an element in design, but to show how the facts contradict the general impression created by commercial programs. Practically, all light sources of equal wattage should be considered as equal in heating effect.

On the basis of *equal foot candles*, however, the higher efficiencies of mercury sources allow the use of less watts than if filament sources are used. There is then an immediate reduction in heat gain. But from the long range point of view it is most important to realize that this reduction in heat gain is only temporary in so far as it may affect the general progress of both the lighting and the air conditioning arts.

A little thought will prove the truth of this. Foot candle levels are never static. Research and application experience have set very high goals. Technological advances in light sources, lighting equipment, and application skill, combine with an innate human preference for lots of light, to advance lighting usage at a steady pace. Therefore, the wattage necessary to produce light moves upward also, at a varying rate depending upon overall efficiencies, but upward nevertheless. As a matter of fact, present practice after only three years of application experience with the fluorescent lamp is providing us with heating wattage equal to that provided by filament sources as usually applied, and

When workers are comparatively fixed in position and the light falls on face and hands, high intensity local lighting by means of fluorescent sources removes any possibility of radiant heat complaints.

Heat gains from lighting are a minor factor in the great majority of industrial interiors. Neither radiant nor sensible heat is a factor in comfort in places such as illustrated.

unless radical changes in efficiency are introduced these heating watts will continue to move upward. This must of necessity influence air conditioning design but it need not be considered as an important factor in comfort.

If present day filament lighting wattages *are* held up as important factors in comfort, then any other source of wattage of equal amounts must produce the same effect. Inasmuch as good filament practice leads to 5 watts per square foot for commercial interiors, and good fluorescent practice is almost at that point now, the evidence points inescapably to the conclusion that heat from *any* light source should be considered as a factor in air cooling design only so far as its thermal constants warrant. To attempt to do otherwise is to saddle the consumer with unwarranted restrictions.

COST DATA

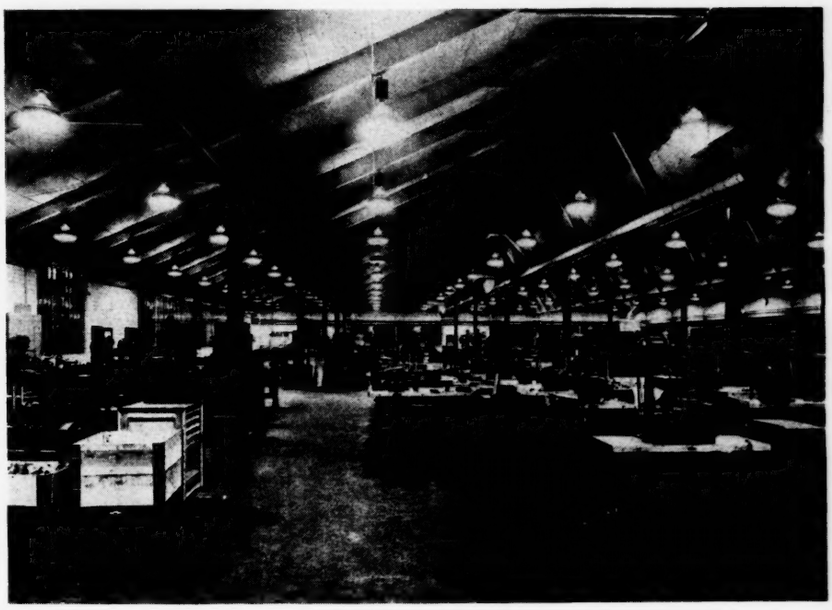
Inasmuch as every choice of a lighting system, when considered in conjunction with an air conditioning system, must sometime or another get around to a question of relative costs, it is helpful to have a method of comparison that has the approval of both the air conditioning industry and the lighting industry.*

*"Lighting and Air Conditioning Design Factors," *Illuminating Engineering*, September, 1941.

Table 7 outlines the procedure for any alternative study involving light sources, lighting methods and levels of illumination. No attempt has been made to simulate an actual study because of the possibility of misunderstanding. Every case carries its own conditions but the constants are reliable and the method insures that all factors will be given due weight.

Lamp cost and luminaire cost should be entered at the price which would be quoted through legitimate channels. Light sources, for example, may be bought on contract, or in standard package quantities over the counter, at established discount.

In the example given, Item 10 on wiring cost was left blank because there is no evidence of sufficient uniformity of conditions or cost to risk the use of a figure which might



Industrial interiors that can be kept painted in light tones utilize the lighting flux in the most efficient manner.

cause embarrassment. It should not be left out of specific studies if additional wiring is involved. Many relighting jobs, on the other hand, may not require rewiring. However, the influence of poor power factor should not be ignored in wiring calculations.

Cost of installing the fixtures should be included in the item of fixture cost. Variations in this item are so great as to preclude the use of average figures in a formula of this nature.

Cost of maintaining the lighting system, that is, minor repairs, cleaning and labor of lamp replacements, should be included using the experience data of the owner, where this is available. If it is not available, a figure of 20 cents per fixture per year can be used.

Items 12 and 30 are ones over which some difference of opinion may arise. It is urged that when preparing an analysis for a specific job, the fixed charge percentage be agreed upon with the customer. Some may prefer to spend money and forget it. Others may wish to use a different rate of depreciation for wiring than for fixtures. Insurance and taxes will vary. However, the fixed percentages used in the example represent good accounting practice and may be used in lieu of anything more pertinent to the situation.

Power costs will, of course, vary with the locality, the magnitude of use, and the class of service. In smaller installations a variation in consumption between two methods or systems may result in KWH charge differences, because of the effect of a sliding scale or block rate.

The hours use of water may not coincide with the hours use of a cooling compressor, although in this example they have been assumed as equal. Under certain conditions, water alone is used during certain periods to effect a reduction in air temperature, thus adding to the total hours during which water is consumed. Again, when water is recirculated after giving up heat in a

TABLE 8 - FUEL EQUIVALENT OF 1 KW HR OF LIGHTING
OR
FUEL EQUIVALENT OF 3415 BTU FROM A LIGHTING SYSTEM

FUEL	EQUIVALENT CENTS PER KW-HR
HAND FIRED FINE COAL	.126
STOKER FIRED FINE COAL	.094
NO 3 FUEL OIL	.280
900 BTU GAS	.325

cooling tower or other device, the gallonage required for losses and the cost of pumping, should be combined for water costs.

Effect on Heating

Thus far the economic discussion has dealt with air cooling. In a large portion of the North American continent, however, there are many months of the year when air heating is necessary. The heat which is given off by appliances, including lighting, can therefore be utilized to reduce the amount of fuel necessary at the furnace to heat the space.

The computation is simple:

$$\frac{\text{Btu per kw-hr}}{\text{Efficiency of heater}} = \text{kw-hr equivalent of heater}$$

$$\frac{\text{kw-hr equivalent of heater}}{\text{Btu per unit of fuel}} = \text{unit of fuel equivalent of kw-hr}$$

Cost per unit of fuel $\times$ unit of fuel equivalent = cost of fuel equivalent of kw-hr.

Acceptable constants would be—12,000 Btu per pound of pea or buckwheat coal; 900 Btu per cu ft of gas; 141,000 Btu per gal of fuel oil; efficiency of hand fired coal plant, 45%; efficiency of stoker fired coal plant, 60%; efficiency of gas fired plant, 75%; efficiency of oil fired plant, 70%.

A sample calculation would disclose the following, assuming a stoker-fired coal boiler:

Consider the fuel equivalent of 1 kw-hr of lighting.

$\frac{3415}{60\%} = 5691$ Btu equivalent at the boiler

$\frac{5691}{12{,}000} = .47$ lb of coal equivalent of 1 kw-hr of lighting

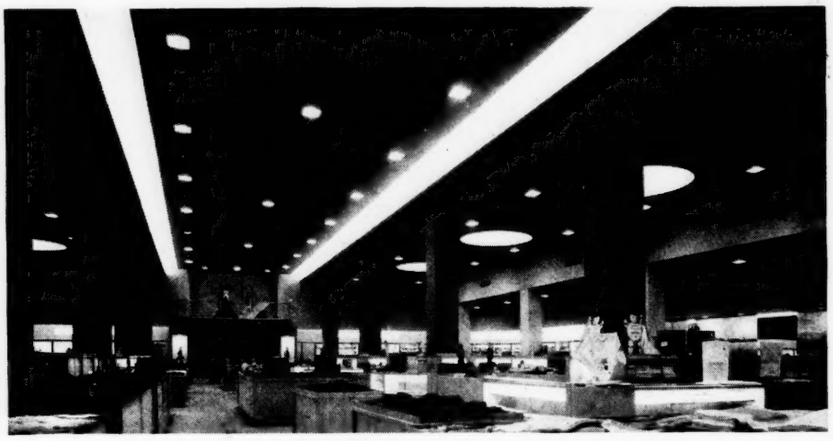
.2 cents per lb $\times$ .47 lb = .094 cents worth of fuel equivalent to 1 kw-hr of lighting.

In an office, therefore, in which 20 kw of lighting were in use, during the winter months an eight-hour day would utilize 160 kw-hr or a fuel equivalent of 15 cents. If the boiler were oil fired the fuel saving would be 45 cents, figuring oil at 8 cents a gallon, and if the boiler were gas fired the fuel saving would be 52 cents per day, figuring gas at 65 cents per 1000 cu ft. When various lighting systems are being analyzed, these savings can be roughly calculated by using the figures given in Table 8.

Another use of these constants would be in connection with specially built lighting fixtures in which radiant and sensible heat was removed through mechanical ventilation. In cold months the removed heat could be reintroduced into the interior with consequent savings in fuel.

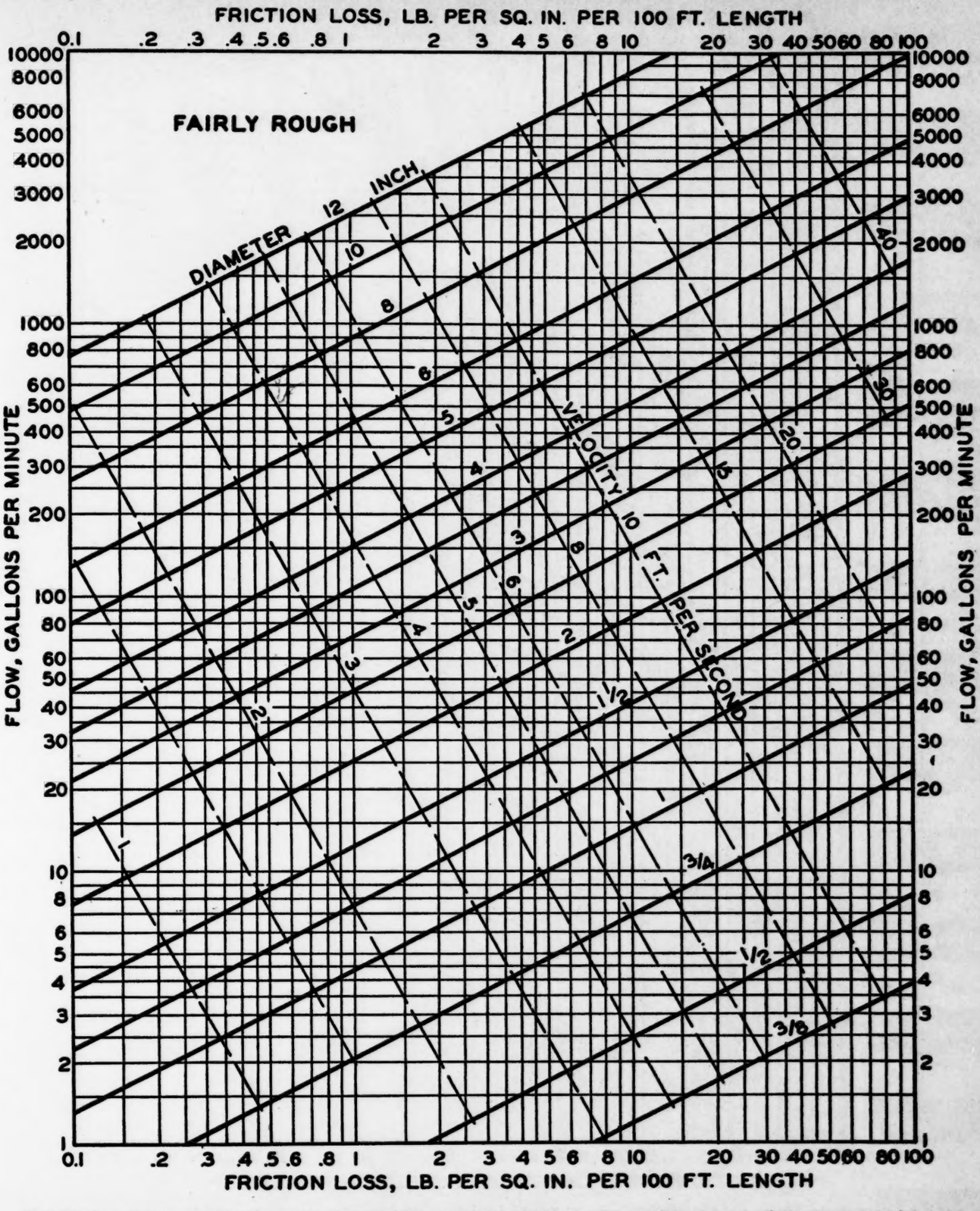
Arithmetically, some of the fuel computations reduce to a very small figure. In large installations over long periods of time the sum total may be respectable in size. In small installations and small areas, however, they are absurdly small. Anyone who has had experience with hand firing a furnace in northern latitudes has little respect for the heating potency of a pound of coal, but a pound of coal is equivalent in hand fired heating to about three 500-watt lamps burning for an hour. Yes, lighting does produce heat, but insofar as this heat influences comfort it is only a small part of a very complex problem.

The air conditioning engineer and the lighting engineer are the custodians of two of the greatest contributions which modern science has made available for human use. If each moves in his appointed sphere with understanding of the interdependent relationships, the consumer will be the recipient of the greatest benefits, but each will also profit in proportion as he serves.



The desire for dramatic effects in mercantile establishments is creating new lighting techniques, requiring large amounts of light flux, and introducing a more rapid rate of obsolescence.

PIPE FRICTION CHART—FAIRLY ROUGH PIPE



The friction charts on this sheet are intended for use in designing water piping, actual diameters of which, generally, will be less in service than actual diameters of new pipe of the same kind. It is assumed that ferrous pipe after a few years' service with the best of waters will have passed from the Fairly Smooth class to the Fairly Rough class. Also see Reference Data 231-232 and the other side of this sheet.

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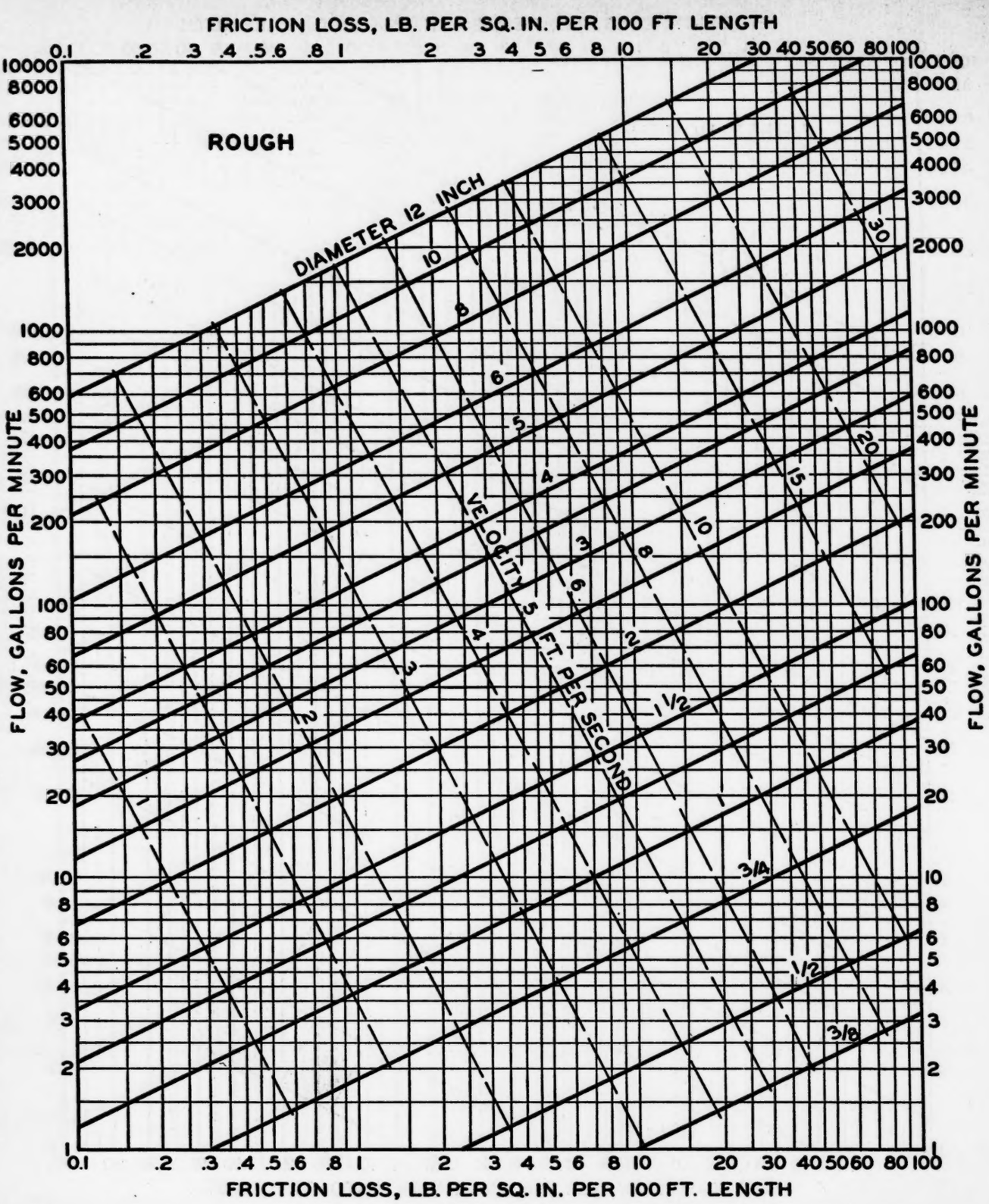
H. & V.'s REFERENCE DATA—233

PIPE FRICTION CHART—ROUGH PIPE



Charts on this sheet, based on National Bureau of Standards data, are for design of water piping. It is assumed that ferrous pipe, after a few years' service with badly corrosive or caking water, will pass from a Fairly Smooth (see Reference Data 231-232) to a Rough category. (Also see note on other side this sheet.) Resulting change in diameter should be estimated and taken into account. Ordinarily the drop in capacity with hard water will be greater in (1) small sizes than in larger, and (2) in hot water lines than in cold water lines.

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H. & V.'s REFERENCE DATA—234

PROFITS IN AIR

Projection-type unit heaters heat this new plant of Thompson Aircraft Products, Inc. Also shown is one of the summer exhaust fans. Plant designed by Albert Kahn Associated Architects and Engineers, Inc.

HOW INDUSTRIAL PLANTS PROMOTE PROCESSES BY CONTROL OF AIR CONDITIONS

METALLURGICAL

FOODSTUFFS

ORDNANCE

CHEMICALS

AIRPLANES

FOUNDRIES

TOBACCO

TEXTILE

BAKERIES

ELECTRICAL

FILMS

INSTRUMENTS

GLASS

MACHINE SHOP

PHARMACEUTICA

PLASTICS

PAPER

RUBBER

PRINTING

PROFITS IN AIR

GLENN L. MARTIN COMPANY

installs automatic spray painting system to protect bomber parts against corrosion; ventilating and paint salvage equipment plays an important part in promoting comfort and efficiency.

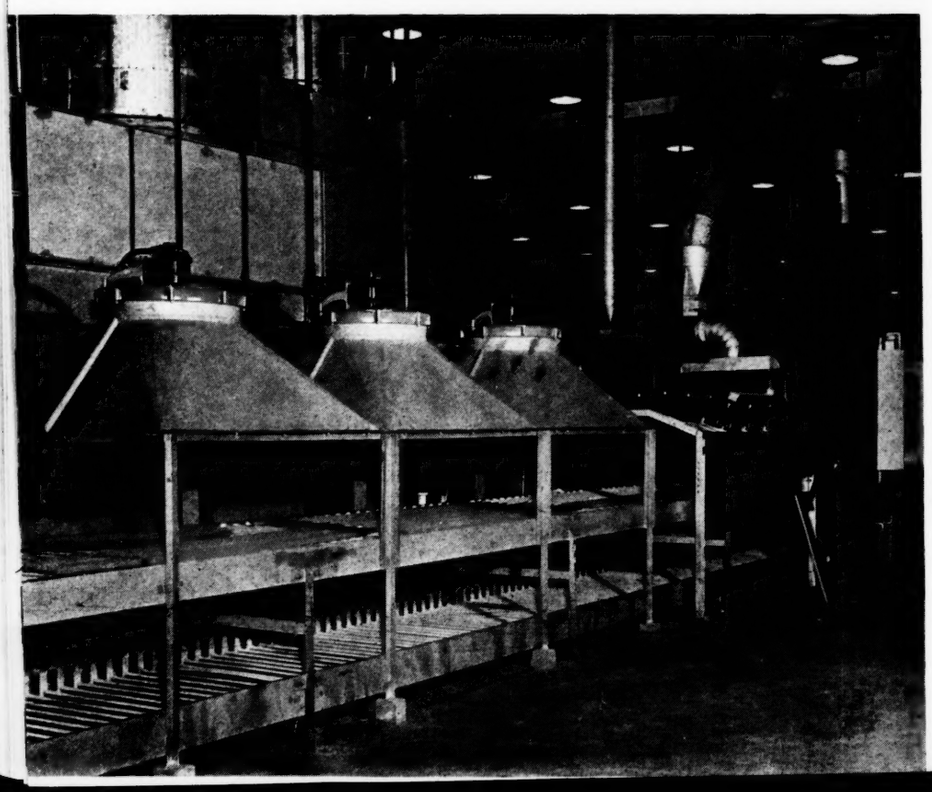
A ROBOT painter that sprays automatically the multitude of parts that go to make up Martin bombers has been installed by the Glenn L. Martin Company of Baltimore. Operated by five men, the device does in a third of the time the work formerly requiring fifteen men, so that ten men badly needed for other work are released from hand-operated spray guns.

The equipment was built especially for the Martin Company by the DeVilbiss Company, and close collaboration between the Martin engineers and the manufacturer insured the incorporation of numerous important features which adapt the system ideally to aircraft spray painting. The water-wash type of spray booths employing veritable waterfalls or water curtains through which exhaust fumes from the spray booths must pass, are especially effective in keeping fine particles of paint from being drawn out through the stack and onto the roof. This eliminates an otherwise serious fire hazard, and considerable maintenance is avoided. The washed out paint pigment collects in the water tank of the booth, from which it is skimmed periodically and salvaged.

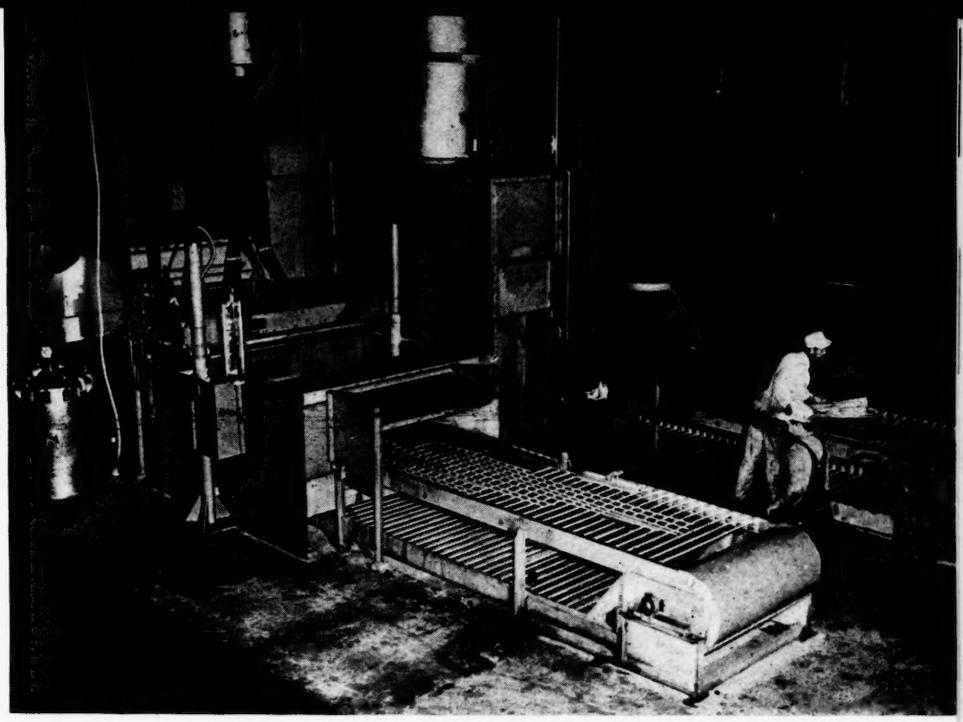
The robot painter itself consists of two complete sets of equipment each made up of cross-bar conveyor, automatic spray booth, infra-red drying oven, and a battery of three cooling fans. The work which is to be painted, mostly small parts that first have been cleaned and anodized, are brought on an overhead monorail conveyor to a station near the robot sprayer. These parts are of various sizes and shapes, some for our own Armed Forces' bombers and others for British planes. Taken from their baskets the pieces are started on the way through the sprayer.

On the cross-bars of the conveyor they are carried under a set of overhead spray guns that play back and forth across the moving pieces. As the belt moves on, the parts are taken through an oven equipped with infra-red lamps to speed the drying, and then through a secondary drying and cooling unit where numerous fans blow air over the parts.

After having passed through this first stage the



Battery of cooling fans used to cool the work as it emerges from the infra-red oven, shown in the background. The pieces are next turned over, placed on the second conveyor, and sent back for painting on the other side.



Overhead view taken at one end of the dual equipment set-up. Airplane parts, painted on one side, are seen in the foreground starting on a duplicate of their first ride through the robot sprayer. When they have ended this second phase of the painting they will have been completely covered with a protective coat of corrosion-resistant paint. In the background may be seen the infra-red oven and exhaust stacks.

parts now painted on one side are taken from the conveyor, turned over, and placed on the second conveyor traveling in the opposite direction, to be sprayed on the other side. The infra-red lamps are so arranged that they may be turned on in units of four or more, depending upon the type of paint being used.

Each side of the automatic spray machine has a separate exhaust system consisting of a 34 in. stack using a propeller-type fan driven by a 1½ hp explosion proof motor. This fan exhausts 7800 cfm at ¾ in. static pressure. The hand spray booths are each equipped with a propeller-type fan and 2 hp motor to exhaust 6800 cfm at ¾ in. static pressure. These three stacks exhaust into one 48 in. round stack. The water curtains of the water wash spray booths are for either hand or automatic operation and are standard equipment with the manufacturer.

The infra-red oven has a separate 14 in. exhaust stack and a small Sirocco type fan driven by a ½ hp motor. Each side has three down draft propeller-type cooling fans, driven by ¼ hp explosion proof motors, and each delivering 5280 cfm of free air. The exhaust system was designed to pull 125 linear feet per minute across the open area of the spray booths.

F. E. Willison, engineer in charge of the Finishing and Plating Group of the Plant and Equipment Engineering Department, was responsible for the design and installation of this exhaust system.

Joseph T. Ryerson & Son, Inc.,

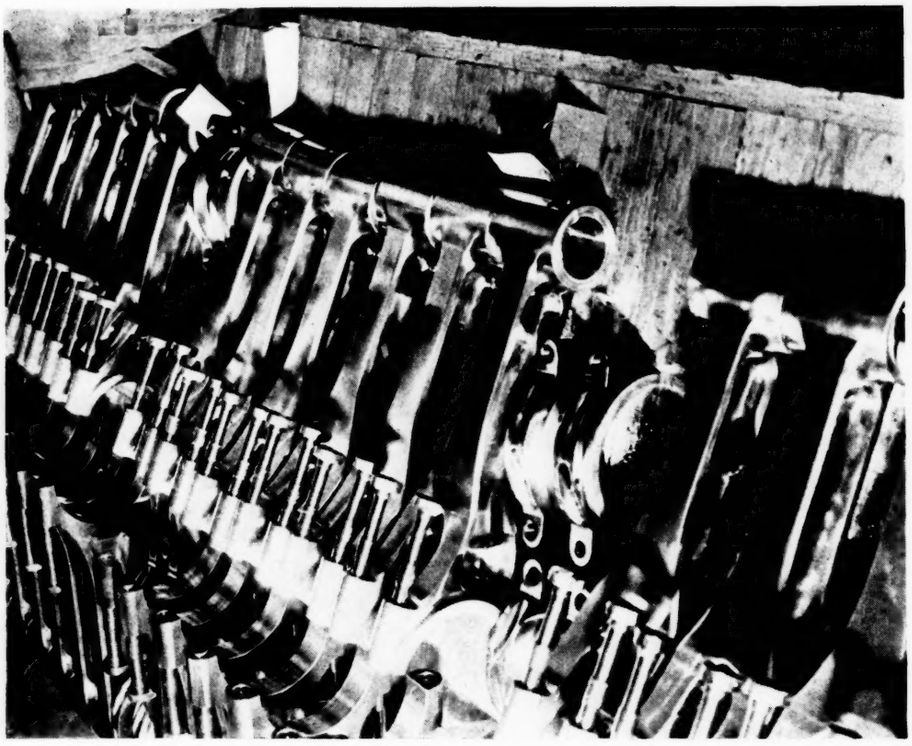
Chicago steel distributor, uses heated discharge air for maintaining dry conditions in warehouses.

Heat conservation through double use of warmed air is practiced by Joseph T. Ryerson & Son, Inc., Chicago, as a war and peacetime economy to reduce heating expenses, conserve fuel, and release coal cars for other shipping purposes. The two main floors of the Ryerson office building are served by a ventilating system which distributes conditioned air through a network of ducts. The outside air is drawn through filters and heating convectors, and is then distributed by a 50,000 cfm fan.

Another network of ducts exhausts the air from the offices and delivers it into three different chambers in which are located fans which pull the air out of the ducts. On many installations this exhausted air is expelled into the outside air.

Ryerson, however, distributes this exhausted air, having a temperature of 75 to 80F, through a network of ducts to various stock sections in which are stored galvanized and full finished sheets of all kinds, mechanical tubing and other steel commodities requiring heated storage. During abnormally low outside temperatures, convectors located in the exhaust fan chambers boost the air temperature.

The whole system is automatically controlled and sufficient heat is always available in the warehouse areas to maintain temperatures well above the dewpoint so as to protect against atmospheric condensation and stock spoilage. Since its installation, the double use heating system has saved thousands of dollars in operating and maintenance costs.



Dehumidifiers prevent the corrosion of finished machine parts.

WAR INDUSTRIES

make wide use of gas-fired dehumidifiers in glass, instrument, plane engine, powder plants, and other applications where moisture is ordinarily a production problem.

IN the prosecution of the task of producing many special materials and precision war tools, better and faster than ever before, elimination of temperature and humidity variables has been essential and air conditioning has been liberally applied. Workers in the enclosed acres of great aircraft and machine plants, as well as technicians and engineers laboring over design boards, produce more under the optimum air conditions provided for them. Precision machine work and precision processes are rendered more precise by control of temperature, humidity and air cleanliness. To a greater extent than ever before, air conditioning is being used as a production tool.

In the midst of all this air conditioning activity and effort, the subcommittee on gas air conditioning for war industries reported to the annual convention of the American Gas Association in October that the special capabilities of direct dehumidification equipment are receiving wide recognition.

The report of the committee went on to say that there are a score or more of arsenals, located in various parts of the country, producing black powder. This powder must be dried to an exact moisture content and must be handled at comparatively low temperature to prevent explosion hazards. On a typical summer day it formerly required up to 15 hr to dry a batch of black powder. Now heat activated dehydration equipment is doing the same job in 3 hr. Production schedules can thus be carried through with a fixed drying time. Practically every pound of black powder produced is dried by this method.

Moreover, practically every square foot of bullet-proof and safety glass produced in this country has the aid of heat activated dehydrators in its production. The rooms in which the plastic binder is handled must be kept at extremely low dewpoints and at comparatively low temperatures. This is accomplished by the use of combination dehydration and refrigeration equipment. This plastic bonded laminated glass is used on all of our airplanes, jeeps, scout cars, and numerous other vehicles.

America's largest manufacturer of altimeters for aircraft is a long-time user of gas-fired dehydrators. The maintenance of low humidities in the assembly

and inspection departments is an essential to prevent sweating hands from itching, tarnishing or rusting highly polished metal surfaces. Furthermore, even a minute amount of water vapor trapped in the instrument on a humid day would precipitate and freeze when the instrument is tested at the specified temperature of —67F, a condition which instruments may meet in use. Low humidity assembly rooms prevent this.

A number of dehumidifier installations are being made in storage rooms to prevent the corrosion of highly finished machine parts. A typical example of this use is to be found in a large aircraft engine plant near the Eastern Seaboard where five of the largest sized standard dehumidifiers are used in two finished part storerooms to prevent tarnish and corrosion of airplane engine parts. Several similar installations are now under consideration.

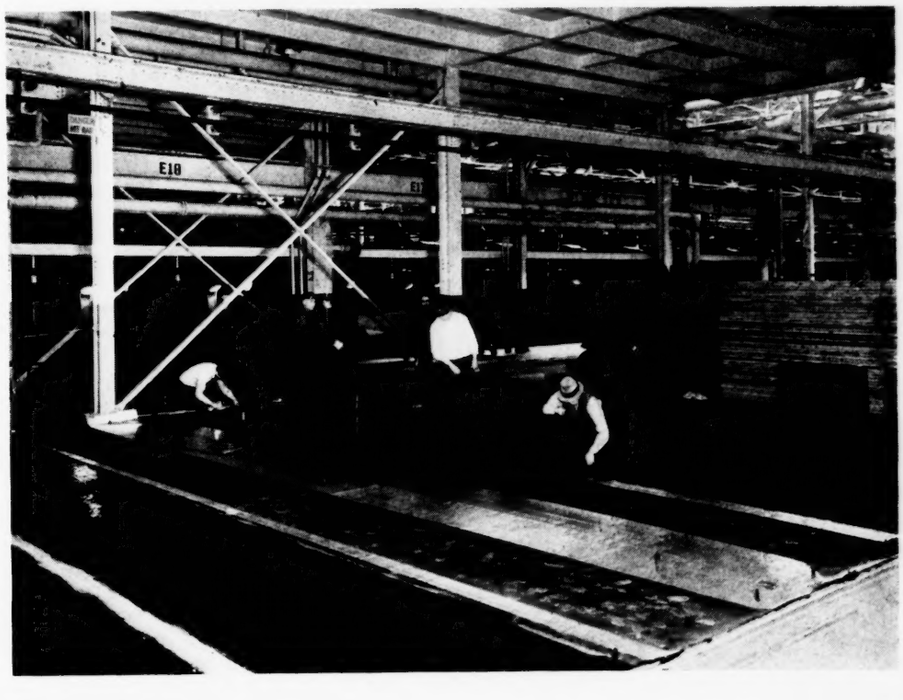
The testing of airplane engines, under stratosphere conditions, presents a typical problem successfully solved by direct dehumidification. Above 50,000 ft the temperature of the air is constant at —67F and it is practically bone dry. To simulate this air condition for testing purposes presents very real difficulties. To cool air to such low temperatures through the use of refrigeration alone causes condensation to appear as frost or ice on the multiple stage cooling coils which blocks air passages. One effective preventive is to cool the air down to the dewpoint just above freezing by refrigeration, then dehydrate this air to a dewpoint of approximately —70F, below which it is carried down to the required final temperature by refrigeration without frosting problems.

America's largest industry, processed foods, is being geared up to produce a wide range of dehydrated foods; thus saving metal used in containers and greatly reducing shipping space. One large U. S. bomber recently carried a full day's ration for a half million people, illustrating the lightness and compactness of the product after the water has been removed.

While most foods are dehydrated by conventional heat drying methods, various phases of air conditioning are already being used in this industry and its acceptance as an important process aid is rapidly increasing. Dehydration equipment can be used to increase the capacity of existing heat drying equipment by removing part of the moisture from the recirculated air in a closed system. Because of the hygroscopic nature of many food products after dehydration, it is apparent that means must be provided to prevent moisture regain during the packaging operation. This is accomplished by maintaining relative humidities below 30% at dry bulb temperatures not exceeding 85F. There are at least nine air conditioning systems installed or under contract for this purpose.

Many other essential processes involve the use of heat activated equipment for air conditioning. Close control of humidity is essential in the processing of "compregnated" wood which is being used experimentally in the production of an all-plastic airplane. Gas-fired air conditioning equipment is being used to provide this important control of humidity. Bone dry rayon cords are being used extensively in place of cotton in the manufacture of improved pneumatic tires. Direct dehumidification equipment provides the essential dry atmosphere.

The report, from which the foregoing is abstracted, concluded by saying that the gas industry must apply the experience gained in the war effort to meet the needs of this country at peace.



Practically every square foot of bullet-proof and safety glass for jeeps and planes is produced in a gas dehumidified plant, such as that containing this vapor-proofed area.

PROFITS IN AIR

MIDWEST ORDNANCE PLANT

uses refrigeration and gas heat to shock test 37 mm. shot. Process involves cooling, then heating, and re-cooling to stress the shot.

AN interesting example of the important contributions to the nation's war effort made by air conditioning and commercial refrigeration dealers is the shot testing equipment designed and built by the Conditioned Air Equipment Co. of Minneapolis for a midwestern ordnance plant.

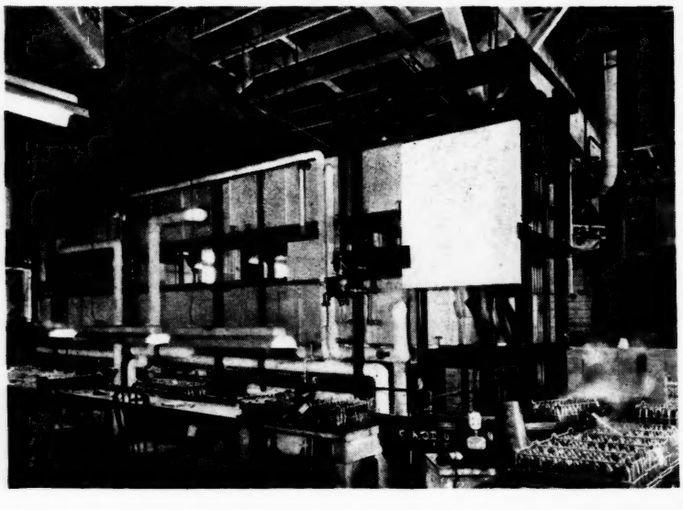
The purpose of the equipment is to shock test 37-mm. shot before inspection by ordnance inspectors. The shot is armor piercing and if any strain, stresses, or defects are in the shot, the shock test cracks them open and the shot is rejected. The problem was to build this equipment to take up the least possible floor space and to tie it in with a streamlined production line. After a survey of the plant's requirements, the Conditioned Air Equipment Co. investigated other equipment for doing similar jobs. Some required up to 1600 sq ft of floor space and considerable labor and maintenance to keep them in operation. So they decided to start out from scratch and came up with a unit taking up only 676 sq ft of floor space and requiring only the part time services of one girl to load and unload.

The unit consists essentially of a conveyor system leading in and out of a series of insulated tanks for water at 40F and 212F. The shot is brought from room temperature to 40F (specifications call for cooling below 60F), in one water bath, is then plunged into a second bath with water at 212F. In a third bath it is brought down to 40F again, thence to an anti-rust bath.

Refrigeration for the unit is provided by a 5-hp General Electric condensing unit connected to an Acme cooler. The condensing unit, water cooling unit, and a circulating pump are mounted below the tanks. A standard G. E. gas-fired boiler supplies heat for the 212F tanks.

An interesting sidelight is a drinking water coil in the bottom of the cold water tanks. This is connected with a bubbler system to provide cold drinking water for employees. Because of health considerations and high room temperatures in the plant, it was necessary to place a mixing valve in the line so that the temperature of the water at the bubblers may be maintained at any desired temperature.

(Left) View of shot-testing equipment in the ordnance plant described. (Right) Samples of shot after having passed through cold and hot baths. Shot at left is perfect, that at right shows up as cracked due to internal defects.



PROFITS IN AIR

MUNSINGWEAR, INC.

sponsors research on insulating properties of underwear. Research setup, at University of Minnesota, includes cooling unit to maintain desired low temperatures for air conditioned chamber.

HOW air conditioning is performing one of its many fine services in facilitating scientific research that it is hoped will prove beneficial to the nation's armed forces is revealed in interesting experiments on the insulating properties of clothing currently being conducted at the University of Minnesota.

These experiments, with Dr. Allan Hemingway, professor of physiology, in charge, are being made under controlled environmental conditions to determine exactly how warm varying types of men's undergarments keep their wearers. Because of the fact that the studies are the first in which actual persons wear garments being tested, the textile industry is extremely interested in what results are obtained. Preliminary experimentation designed to set up standard tests applicable to all types, thicknesses, and weaves of materials in men's underwear began last November. Dr. Hemingway is working under a grant from Munsingwear, Inc., Minneapolis, and results of the research, when completed, will be turned over to the U. S. Army Quartermaster Department. They will also be published as a contribution to science.

The air conditioning equipment being used in the studies is relatively simple. It consists first of a chamber 7 x 10 ft in area and 7 ft high, insulated with rock wool and cork. A 1 hp refrigeration unit enables cooling the space to 32F, while a 2000-watt nichrome coil unit permits heating the room up to 100F. These units are thermostatically controlled and maintain dry bulb temperatures which vary no more than ½F from set points. A humidistat also governs the cooling unit in addition to a nozzle spray humidifier and provides a wet bulb control allowing variations of no more than 5%, plus or minus, from set points.

The subjects, clad in the undergarments being tested, are seated in a specially-designed chair in the air conditioned chamber. The chair is of the folding deck type from which the canvas has been removed and replaced with a netting designed to provide the least possible amount of insulation. In this way all protection except that offered the subject by the particular garment he is wearing during the test is reduced as far as possible.

During preliminary tests the room has been kept at temperatures fixed at points between 60 and 70F with a relative humidity of 50%. Exactly what temperature and humidity points will be maintained after actual testing begins is now being studied. At 70F a person clad only in an undergarment loses heat quickly. In order to be able to measure this body cooling rate, which Dr. Hemingway is using as the index of the insulating property of garments, it is necessary to start with the bodies of the subjects at a fixed temperature. For this purpose Dr. Hemingway will employ diathermy, running a high frequency electric current through the body of his subject to restore body heat to normal or ½F above normal. Then he will shut the current off and measure the rate of drop in body temperature. These measurements will be taken with thermocouples, sensitive temperature-detecting instruments, attached at twelve different points on the bodies of the subjects. These points are on the arms, legs, heads, necks, and trunks. By thus spreading the instruments over the body, the differentials in rates of cooling of the various members and parts can be checked. Readings of the temperatures, taken over periods lasting between two and six hours, will be made with galvanometers or potentiometers. The thermocouples used to detect the temperature changes on most parts of the body are of the simple sort requiring actual contact between them and the body. To test the temperatures of the exposed portions of the body such as the head and face, a Hardy pyrometer is used. This, like the simple thermocouples, detects temperature changes but does so through the body heat radiated rather than through contact, as in the former case, with the body itself.

WASHINGTON NEWS

Summarized by Loring F. Overman. Details of Fuel Oil Ration Plan; Nelson Curtails Certain Construction; J. F. Wilbur Is New P&H Branch Chief

"Get things done; win the war—and let the chips fall where they may."

To a greater extent than before *this* seems to be the trend in Washington as November ushers in the realization that nearly a year has passed since the Pearl Harbor thrust set the Nation howling for revenge. That the year has seen too little of revenge and too much of vacillation, indecision and clinging to the remnants of "business as usual" is being effectively emphasized in Washington.

While a machine so ponderous as that of the Federal Government cannot be reversed overnight, the brakes are being applied, the sparks are flying, there are screeches of protest here and there. But the pendulum appears about ready to describe a new arc in which *immediate* relation to the war effort is to be the determining factor.

To many it will seem that this has been the objective in the past, as indeed it has. But there have been reservations of the type quite natural to a nation that rather expected to win the war with one hand and keep the other busy at usual occupations.

Now, however, with nearly five million sons, brothers, fathers and even wives and daughters in the armed forces a new and more personal pressure demands that the job be finished—and quickly.

As a result WPB, Army and Navy, Congress, the Manpower Commission and numerous other agencies have taken the bits in their teeth and are getting set for a bolt in whatever "win the war now" direction their respective assignments appear to lead them. As in the past there will doubtless be errors. Indications are, however, that they will be errors of action rather than inaction.

Building Ban

WPB Director Donald Nelson's recent ban on all unessential construction — even that broadly classed as defense-inspired and proceeding under Federal, State and Local governments—strikes the keynote. Ending work on some $33 billion worth of construction already under way, the order is intended simply to release materials actually needed in making armaments *now*, and to make available to war-producing industries thousands of skilled and unskilled workmen now engaged in occupations related to the war but not actually essential to a Victory Now program.

One-Third Drop

As a result of the order a 33 1/3% decline in the building total for 1943, as compared with the estimated total of $12 billion for 1942, is forecast by the Statistics Division of WPB. As reported by Stacy May, WPB Director of Statistics, to the annual meeting of the American Institute of Steel Construction, held October 2 in Colorado, the drop of one-third or more will apply to all building and engineering construction, exclusive of shipbuilding.

Preliminary figures submitted by the U. S. Department of Commerce to a Senatorial investigating committee under the Chairmanship of Senator Murray place the 1943 total at approximately 7½ billion dollars.

The total for 1942, roughly estimated at between 11 billion and 12 billions of dollars, is expected by WPB to top considerably the previous all-time record, established in 1927, with a total slightly less than $11 billion.

Procurement Cleared

Another WPB October directive clearing the way to eliminate some of the red tape interfering with war production is Mr. Nelson's Procurement Directive No. 2, Amended, relating to placing of war contracts by negotiation. While major companies in the heating, ventilating and air conditioning industry may not find the procedure greatly different than in the past, the directive clears the way for the assignment of a larger amount of war work to any firms, large or small, not now tied in with the direct armament program.

The drastic procurement order—a far cry from the pre-war days of advertised bids and later the much-discussed cost-plus-a-fixed fee contracts—offers striking proof of how far Washington has moved in recent weeks toward a get-it-done objective, regardless of cost.

The new buying order will implement the program of the Smaller War Plants Division of WPB, reported in last month's Washington News as getting away to a fast start on its bits-and-pieces program under the direction of Lou Holland.

With the way cleared for direct negotiation, activities of the Smaller War Plants Division may prove of interest to units of the heating and ventilatng industry not yet closely allied with war production.

A.C. Drive Successful

One of Washington's pleasant surprises, it appears, is the voluntary response given to drive to purchase from private owners, major air conditioning equipment needed in war industries. Although it was first thought likely that use of a WPB big stick might be necessary to induce owners of equipment to part with desired units, it is reported by the WPB conservation division, in charge of the program, that "The industry and donors of equipment have grabbed the ball and are doing a good job of it."

Policies have been established and methods of procedure will soon be announced, according to J. Jex, Jr., chief, Air Conditioning and Refrigeration Section, Used Equipment Branch, WPB Division of Industry Operation.

First units will be removed from stores, office buildings and the quarters of other donors shortly after January 1, according to Mr. Jex. Donors will be reimbursed at full installation prices, less 5% per year for depreciation. They will also be reimbursed for all dismantling costs and for any building alterations required by removal of equipment.

Original manufacturers will handle all details of removal, reconditioning and re-erecting on behalf of the Defense Plants Corporation. No manufacturer will be permitted to remove or service another manufacturer's equipment.

"It should be understood that the program of accepting air conditioning equipment from patriotic donors will not be for the primary purpose of contributing to the comfort of those in war plants," said Mr. Jex. "Units acquired will be installed only where they are physically essential to the manufacturing process or to completion of a finished article.

"The first program will involve essential air conditioning of synthetic rubber plants; the second, dry blast steel furnaces. The third group to be covered will be general plants where consistently conditioned air affects the end product. Plants producing lenses are examples, as are those where magnesium and aluminum are cast and machined.

"The program is meeting with astounding response on the part of the air conditioning industry and prospective donors. Already offered are large numbers of units within the desired range—100 to 3000 horsepower—and countless numbers of smaller units for which the program can find no outlet.

"Although all donors would doubtless prefer to keep their equipment, and manufacturers would quite naturally prefer to make new equipment, the actual requirements of the war effort prevent such an ideal arrangement. We believe that the current program offers the industry a desirable alternative by keeping a portion of its plant and man-power in the business of servicing and installing major equipment and at the same time leaving in the vacated office buildings and stores a most desirable market for post-war operation."

A.C. is Guinea Pig

The air conditioning acquisitioning program is being watched with interest by WPB executives, who regard the movement as a test of what may be accomplished in acquiring for war industries other essential equipment for which shortages may develop as the war effort progresses.

Besides cooperating with the acquisition program administered by the Used Equipment Branch of Industry Operations, the Air Conditioning and Commercial Refrigeration section headed by Sterling Smith also has important plans in the making. Details of the plans will not be ready for release until sometime in November, but their purpose, it is said, will be to "gather up loose ends."

Wilbur New P.&H. Chief

W. Walter Timmis, tall and impressive in the uniform of a Lieutenant Commander, U. S. N., was a visitor late in October at the new offices of he WPB Plumbing and Heating branch, which he headed until he recently resigned to enter the service.

Filling the vacancy is Joseph F. Wilbur (Office of Hollis French, Boston), under whose direction the branch is busy re-casting its role under new programs that restrict continental building and place emphasis on ship construction and overseas military requirements.

During October the Plumbing and

Joseph F. Wilbur, new chief of the Plumbing and Heating Branch, WPB

Heating branch issued order L-75, as amended October 20—placing restrictions on sale and delivery of coal stokers. This order provides, among other things, that: no person shall place an order for the manufacture of a Class A coal stoker (grate area 36 sq ft or less, coal feed over 60 lb per hr) unless such order is accompanied by the authorization of the Director General for Operations on PD 668. . . . no manufacturer of a Class A coal stoker shall deliver or transfer any such stoker except: In accordance with specific authorization given by the Director General for Operations, and such Class A stokers as are listed as unfilled orders in the schedule required to be filed with the War Production Board by paragraph (b) (3) of this order.

On the 4th day of November, 1942, each manufacturer of Class A coal stokers shall file a schedule of production and delivery with WPB's Plumbing and Heating Branch, Washington, setting forth the following information:

All unfilled orders for Class A coal stokers received on or before Nov. 4, a brief description of each stoker, the schedule date of each delivery, and the name and address of the person ordering each stoker, together with any preference rating applied or extended to such delivery.

Until Nov. 23 the delivery provisions shall not apply to any order for Class A coal stoker to be used by the Army, Navy, Maritime Commission or War Shipping Administration of the United States.

No person shall manufacture a Class B stoker.

Oil Situation

Details of the methods by which the limited stocks of fuel oil will be allocated to assure adequate supplies for essential heating, industrial and other purposes were made public October 19 by Price Administrator Leon Henderson with issuance of the formal fuel oil rationing regulation.

Major provisions of the measure, titled Ration Order No. 11, Fuel Oil Rationing Regulations, curtail the use of fuel oil in the 30-state rationed area, set forth the maximum amounts which may be used for domestic cooking, lighting, and hot water, restrict fuel oil use for heating any premises, including apartment houses and other multiple dwellings, and bring under strict control fuel oil used for commercial and industrial purposes.

With very few exceptions, the regulations curtail fuel oil use only for heating and hot water purposes. The formula curtailment is 33⅓%. Actually, each individual curtailment will vary greatly depending upon the thermal efficiency of the premises. The minimum cut is 15%.

The order divides the 30-state area in the East and Mid-West, in which rationing will take place, into four thermal zones, and the heating year, October, 1, 1942 to September 30, 1943 into five periods. In addition, six different classes of consumer coupons are to be used. Class I coupons are numbered 1, 2, 3, 4, and 5, designating the periods of the heating year during which the coupons are valid, and have a value of 10 gallons per unit for the first heating period. Values for later heating periods will be determined in accordance with weather conditions. Class II coupons are similar to Class I, with the exception that they will have a value of 10 units or 100 gallons for the first period. These coupons will be used for rations for the operation of equipment furnishing heat, and both heat and hot water. Class III, IV, V, VI consumer coupons differ from the first two classes in that they have fixed values stated on their faces, these values being 1, 5, 25, and 100 gallons, respectively. Rations for fuel oil used for purposes other than space or hot water heating, such as domestic cooking and lighting, operation of machinery and the like, will be allotted in these coupons.

As regards fuel oil ration for a private dwelling, which is defined as a building designed for the occupancy of fewer than four families, the order contains tables reflecting the formula previously announced by OPA—namely, determination of the individual homeowner's allotment by means of a floor area heat loss formula and a percentage of past fuel consumption. By means of these guides, which have been approved by leaders in the petroleum, insulation, equipment and burner industries, a base ration range is established so the houses which are heated by oil both in the cold north and the warmer south will share equitably in the heat that the reduced fuel supplies allow.

The heat loss formula is applied by multiplying the floor space of the

house used for living or sleeping quarters by the number of degree days for the zone in which the house is located. This figure in turn is divided by two constants, 7,300 and 5,600, which will establish the maximum and minimum amount of fuel oil necessary to maintain a 65F temperature. The amount of fuel oil consumed during the base heating season (June 1, 1941 to May 31, 1942) for heating purposes, is adjusted to normal by reference to the average degree day figure for the zone in which the house is located and reduced 33⅓%. If this modified consumption figure falls within the maximum and minimum range, that is the ration for the particular house. In instances where it falls above the range, the maximum or the range is the allotment; where the two-thirds consumption is below the minimum amount set in the range, the ration will be either the minimum range figure or 85% of the June 1941-May 1942 consumption figure—whichever is lower.

A supplemental ration for heating, ranging from 125 gallons in thermal zone "A" to 50 gallons in thermal zone "D", is allowed if one or more children less than 4 years old occupy the dwelling.

The fuel oil allowance will be calculated by the local rationing board, with the homeowners required to submit figures on floor space, past season's fuel oil consumption, fuel oil inventory as of October 1 and certain other specified information. In instances where consumption for a private dwelling during the twelve months ended May 31, 1942 is not available and cannot be calculated, as would be the case of a house erected during or since that time, the fuel oil ration is the midpoint of the ration range.

The order specifies that a ration will not be granted for heating equipment burning fuel oil installed since July 31, 1942 unless the oil burning equipment was specified in the construction contract and the foundation under the main part of the building in which the equipment was to be installed was completed before July 31, 1942.

The ration for hot water for private dwellings is determined by segregating the amount of oil which the householder used for this purpose during the past heating year from his consumption for heating purposes, which is, therefore, not included in the computation of the allotment for heating purposes. The allomeent for hot water, which, however, is included in the heating ration, is set at 20 gallons per month for the first person and 5 gallons per month for each additional person occupying the house, less 33⅓%.

The order contains separate provisions for allotments of fuel oil for heating and hot water for premises other than private dwellings, including multiple dwellings such as apartment houses, rooming houses (with four or more rooms for rent), institutions and commercial establishments. This ration, application for which is to be made on form F-1101, is set at 66⅔% of the amount of fuel oil consumed for these purposes during the base period adjusted to normal. If the fuel oil is used for supplying hot water only, the allotment is established at 66⅔% of the amount used for tha purpose during the base period. If the ration is for heating purposes only, the amount used for hot water is to be deducted in computing the allotment. The amount of fuel oil on hand October 1st is deducted from the ration in any case.

The fuel oil allotment for these purposes is issued on the form of Class I and II coupons in the same manner as for private dwellings. The coupons, which will represent the ration for the entire heating year, will be proportionately divided between the 5 heating periods. Where the ration is allotted for hot water alone, Class III, IV, V and VI coupons will be issued.

Fuel oil for equipment used only for furnishing hot water as an integral part of a commercial, industrial, agricultural or extractive process or for purposes directly related to the public health or safety may be obtained on form R-1102, for three month periods. Such uses are not curtailed.

The order contains provision for the issuance of auxiliary rations for both heat and hot water for certain specified purposes and under specific conditions. Extra rations for heating premises may be allowed, if a higher temperature is required than that which can be maintained by the regular ration, for: (1) conducting an industrial, agricultural, or extractive process; (2) for the performance of work directly related to the war effort, if the work is of such a nature that the worker performing it can operate efficiently only at a higher temperature; (3) for the care and treatment of patients in a hospital or sanatorium; (4) for the care and maintenance of exhibits in an aquarium, zoological, or botanical garden, art gallery, museum, or similar establishment to which the public is admitted, which is maintained by an educational or charitable institution, or by a government agency; (5) for the care of a person who is ill or infirm; (6) for the examination or treatment of the sick; (7) for the care of children under four years of age, or of aged persons, in a building used primarily as an orphanage, school, or home for the aged.

Rigid control over the transfer of fuel oil is provided by the provisions of the order. It requires that every transfer of fuel oil (with a few specific exceptions) be accompanied by an exchange of coupons or authorized certificates or acknowledgments.

New Oil Threat

Coincident with the issuance on October 20 of OPA's detailed instructions for handling fuel oil rationing, a threatening new note crept into the oil shortage picture.

Heretofore the need for rationing gasoline and fuel oil has been laid to the transportation bottleneck. Into the record now is read the progress report on petroleum filed by the Senate Mineral Resources Subcommittee, wherein it is promised that unless new oil reserves are discovered the nation will soon face another threat of shortage.

The report points out that the country is already drawing on accumulated stocks of oil, while production is falling off and the search for new fields has practically ceased. The Committee recommends that before war requirements draw more heavily upon oil reserves, the five agencies now acting independently on production and distribution of oil co-ordinate their activities more closely, and that exploration activities be encouraged with Government loans to wildcatters and other exploring organizations.

Coal Miner-ettes?

With fuel oil under scrutiny from both production and delivery angles, there was also interesting news from coal mines. Solid Fuel Coordinator Harold Ickes reported October 13 that the coal mining industry, faced with a shortage of manpower, has begun to hire women to keep pace with the Nation's expanding wartime fuel requirements.

No instance was reported, however, where women are being substituted for actual mining or other underground work in American mines. The coal mining industry has experienced a net loss of more than 50,000 men since January 1, according to surveys made by the Solid Fuels Office.

Pipe Line Extension

Announcement was made on October 28 that the 24 in. pipe line under construction between Texas and Illinois will be extended to the east. The new extension will run from Norris City, Ill., across Indiana and Ohio to Phoenixville, Pa., from where branch lines will be laid to Philadelphia and New York. The total line will then be 1388 miles long.

Degree-Days for September, 1942

HEATING AND VENTILATING'S 15th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Sept., 1942	Degree-Days, Sept., 1941	Degree-Days, Sept., Normal	Season, 9/1/42-9/30/42	Season, 9/1/41-9/30/41	Season, Normal 9/1-9/30	Normal, 9/1-6/30
Abilene, Tex.	19	1	0	19	1	0	2061
Albany, N. Y.	172	128	72	172	128	72	6580
Albuquerque, N. Mex.	16	51	0	16	51	0	4298
Alpena, Mich.	273	182	222	273	182	222	8299*
Anaconda, Mont.	(a)	513	335	(a)	513	335	8357**
Asheville, N. C.	86	11	0	86	11	0	4232
Atlanta, Ga.	37	0	0	37	0	0	2890
Atlantic City, N. J.	66	23	0	66	23	0	5176
Augusta, Ga.	18	0	0	18	0	0	2161
Baker, Ore.	187	388	258	187	388	258	7163
Baltimore, Md.	50	8	223	50	8	223	4533
Billings, Mont.	236	336	189	236	336	189	7119
Binghamton, N. Y.	157	113	108	157	113	108	6808
Birmingham, Ala.	35	0	0	35	0	0	2352
Bismarck, N. D.	351	280	222	351	280	222	9192
Block Island, R. I.	91	70	0	91	70	0	5788
Boise, Idaho	106	223	102	106	223	102	5552
Boston, Mass.	103	89	48	103	89	48	6045
Bozeman, Mont.	(a)	474	336	(a)	474	336	8521**
Buffalo, N. Y.	154	73	75	154	73	75	6822
Burlington, Vt.	223	202	144	223	202	144	7514
Butte, Mont.	(a)	551	344	(a)	551	344	8272
Cairo, Ill.	74	7	0	74	7	0	3909
Canton, N. Y.	230	196	189	230	196	189	8020
Charles City, Iowa	261	117	93	261	117	93	7588
Charleston, S. C.	8	0	0	8	0	0	1769
Charlotte, N. C.	38	0	0	38	0	0	3120
Chattanooga, Tenn.	61	0	0	61	0	0	3118
Cheyenne, Wyo.	291	312	240	291	312	240	7466
Chicago, Ill.	193	51	0	193	51	0	5957
Cincinnati, Ohio	135	24	0	135	24	0	4684
Cleveland, Ohio	135	53	27	135	53	27	6155
Columbia, Mo.	145	47	0	145	47	0	4922
Columbia, S. C.	21	0	0	21	0	0	2364
Columbus, Ohio	133	26	0	133	26	0	5398
Concord, N. H.	190	201	168	190	201	168	7353
Concordia, Kan.	151	59	0	151	59	0	5315
Dallas, Tex.	34	0	0	34	0	0	2256
Davenport, Iowa	183	60	0	183	60	0	6289
Dayton, Ohio	136	34	0	136	34	0	5264
Denver, Colo.	153	166	72	153	166	72	5874
Des Moines, Iowa	193	78	0	193	78	0	6384
Detroit, Mich.	188	61	42	188	61	42	6490
Devils Lake, N. D.	404	340	276	404	340	276	9970
Dodge City, Kan.	99	60	0	99	60	0	5035
Dubuque, Iowa	213	74	36	213	74	36	6790
Duluth, Minn.	357	261	270	357	261	270	9443
Eastport, Me.	253	252	276	253	252	276	8520
Elkins, W. Va.	140	88	63	140	88	63	5697
El Paso, Tex.	7	0	0	7	0	0	2428
Ely, Nev.	281	417	0	281	417	0	0
Erie, Pa.	120	59	36	120	59	36	6273
Escanaba, Mich.	310	193	243	310	193	243	8771
Evansville, Ind.	126	19	0	126	19	0	4244
Fort Smith, Ark.	51	3	62	51	3	62	3147
Fort Wayne, Ind.	184	58	0	184	58	0	5925
Fort Worth, Tex.	21	0	0	21	0	0	2148
Fresno, Calif.	0	5	0	0	5	0	2334
Galveston, Tex.	7	0	0	7	0	0	1016
Grand Junction, Colo.	39	123	0	39	123	0	5548
Grand Rapids, Mich.	192	70	57	192	70	57	6535
Green Bay, Wis.	258	116	132	258	116	132	7825
Greensboro, N. C.	59	4	0	59	4	0	3529
Greenville, S. C.	34	0	0	34	0	0	3380
Harrisburg, Pa.	92	30	0	92	30	0	5357
Hartford, Conn.	110	104	48	110	104	48	6036
Hatteras, N. C.	2	0	0	2	0	0	2571
Havre, Mont.	245	369	270	245	369	270	8700
Helena, Mont.	278	436	251	278	436	251	7898
Houston, Tex.	15	0	0	15	0	0	1157
Huron, S. D.	299	157	123	299	157	123	8004
Indianapolis, Ind.	133	27	0	133	27	0	5298
Ithaca, N. Y.	182	114	96	182	114	96	6719
Kansas City, Mo.	136	43	0	136	43	0	4956
Kewanee, Ill.	186	46	78	186	46	78	6139
Knoxville, Tenn.	75	0	0	75	0	0	3670
La Crosse, Wis.	238	111	96	238	111	96	7322
Lander, Wyo.	253	371	276	253	371	276	7947

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Kewanee, and Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; J. M. Hartman, Engineering Department, Kewanee Boiler Corp., Kewanee, Ill., and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table Concluded on Next Page.

Degree-Days for September, 1942 (Concluded)

HEATING AND VENTILATING'S 15th year of publication of monthly degree-day data

City	Monthly Degree-Days			Cumulative Degree-Days[1]			Year[2]
	Degree-Days, Sept., 1942	Degree-Days, Sept., 1941	Degree-Days, Sept., Normal	Season, 9/1/42-9/30/42	Season, 9/1/41-9/30/41	Season, Normal 9/1-9/30	Normal, 9/1-6/30
Lansing, Mich.	238	104	114	238	104	114	7048
Lewiston, Me.	204	223	165	204	223	165	7707
Lincoln, Neb.	174	71	0	174	71	0	5999
Little Rock, Ark.	57	3	0	57	3	0	2811
Livingston, Mont.	(a)	422	227	(a)	422	227	7205
Los Angeles, Calif.	3	4	0	3	4	0	1504
Louisville, Ky.	107	7	0	107	7	0	4180
Lynchburg, Va.	60	10	0	60	10	0	3980
Macon, Ga.	23	0	0	23	0	0	2201
Madison, Wis.	231	91	87	231	91	87	7429
Marquette, Mich.	310	196	225	310	196	225	8693*
Memphis, Tenn.	61	2	0	61	2	0	2950
Meridian, Miss.	36	0	0	36	0	0	2160
Milwaukee, Wis.	238	105	84	238	105	84	7245
Minneapolis, Minn.	282	137	93	282	137	93	7850
Modena, Utah	162	274	156	162	274	156	6562
Montgomery, Ala.	19	0	0	19	0	0	1884
Nantucket, Mass.	91	89	63	91	89	63	5957
Nashville, Tenn.	73	1	0	73	1	0	3507
New Haven, Conn.	91	72	39	91	72	39	5895
New Orleans, La.	5	0	0	5	0	0	1024
New York, N. Y.	53	26	0	53	26	0	5347
Nome, Alaska	(a)	603	744	(a)	603	744	14580**
Norfolk, Va.	24	0	0	24	0	0	3350
Northfield, Vt.	262	272	276	262	272	276	8719*
North Head, Wash.	238	203	255	238	203	255	5452**
North Platte, Neb.	201	132	42	201	132	42	6366
Oakland, Calif.	105	68	90	105	68	90	3143**
Oklahoma City, Okla.	66	14	0	66	14	0	3613
Omaha, Neb.	184	77	0	184	77	0	6131
Oswego, N. Y.	145	121	114	145	121	114	7088
Parkersburg, W. Va.	124	30	0	124	30	0	4775
Peoria, Ill.	189	61	3	189	61	3	6109
Philadelphia, Pa.	47	12	0	47	12	0	4855
Phoenix, Ariz.	0	0	0	0	0	0	1405
Pittsburgh, Penn.	108	32	0	108	32	0	5235
Pocatello, Idaho	161	307	156	161	307	156	6655
Portland, Me.	202	216	162	202	216	162	7218
Portland, Ore.	51	113	105	51	113	105	4469
Providence, R. I.	84	76	63	84	76	63	6015
Pueblo, Colo.	122	134	6	122	134	6	5514
Raleigh, N. C.	40	1	0	40	1	0	3234
Rapid City, S. D.	284	235	144	284	235	144	7118
Reading, Pa.	83	35	0	83	35	0	5389
Redding, Calif.	0	11	0	0	11	0	2451
Reno, Nev.	142	216	144	142	216	144	5892
Richmond, Va.	49	7	0	49	7	0	3695
Rochester, N. Y.	158	113	72	158	113	72	6732
Roseburg, Ore.	61	143	111	61	143	111	4428
Roswell, N. Mex.	49	32	0	49	32	0	3484
Sacramento, Calif.	2	8	0	2	8	0	2653
St. Joseph, Mo.	158	62	0	158	62	0	5161
St. Louis, Mo.	116	33	0	116	33	0	4585
Salt Lake City, Utah	110	167	18	110	167	18	5555
San Antonio, Tex.	13	0	0	13	0	0	1202
San Diego, Calif.	0	0	0	0	0	0	1645
Sandusky, Ohio	133	36	0	133	36	0	6208
San Francisco, Calif.	155	79	114	155	79	114	3264**
Sault Ste. Marie, Mich.	341	264	276	341	264	276	9285**
Savannah, Ga.	6	0	0	6	0	0	1490
Scranton, Pa.	128	90	60	128	90	60	6129
Seattle, Wash.	113	185	186	113	185	186	4934**
Sheridan, Wyo.	243	340	264	243	340	264	8008
Shreveport, La.	31	0	0	31	0	0	1938
Sioux City, Iowa	233	115	33	233	115	33	6898
Spokane, Wash.	120	284	192	120	284	192	6355
Springfield, Ill.	148	46	0	148	46	0	5373
Springfield, Mo.	130	47	0	130	47	0	4428
Syracuse, N. Y.	167	139	96	167	139	96	6893
Tacoma, Wash.	143	212	207	143	212	207	5181**
Terre Haute, Ind.	127	31	0	127	31	0	4872
Toledo, Ohio	164	48	9	164	48	9	6077
Topeka, Kan.	134	53	0	134	53	0	4969
Trenton, N. J.	66	34	0	66	34	0	4933
Utica, N. Y.	176	148	182	176	148	182	6796
Valentine, Neb.	264	173	93	264	173	93	7039
Walla Walla, Wash.	29	126	30	29	126	30	4808
Washington, D. C.	59	9	0	59	9	0	4626
Wichita, Kan.	114	46	0	114	46	0	4673
Williston, N. D.	333	342	270	333	342	270	9323
Winnemucca, Nev.	135	290	192	135	290	192	6426**
Yakima, Wash.	32	176	120	32	176	120	5599

*Includes August. **Includes July and August. (a) Data not yet available.

[1]Cumulative data identical with monthly figures for September only. In subsequent months, cumulative figures will show record for whole heating season to and including month in question.

[2]Figures in this column are normal totals for a complete heating season, September to June, incl.

NEWS OF THE MONTH

Cast Iron Boiler Men Discuss 40-Inch Boiler Tests; Objective is Continued Improvement of I-B-R Code

JOHNSTOWN, PA.—Engineering representatives of the members of The Institute of Boiler and Radiator Manufacturers met here September 11 to discuss certain problems in connection with the testing and rating of boilers of approximately 40-inch grate width.

In addition to 21 engineering representatives of the various manufacturers of cast iron boilers and radiators, Allen J. Johnson and C. F. Golding of the Anthracite Industries Laboratory, and Dr. Rose and Dr. Johnson of the Mellon Institute, were present.

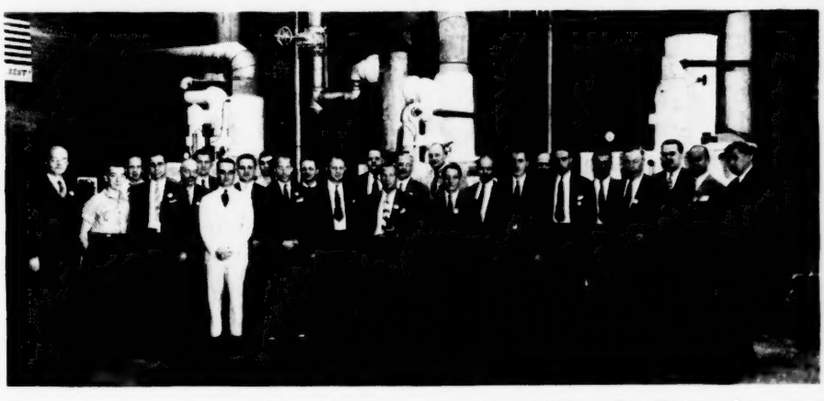
In opening the meeting, Chairman J. P. Magos stated that the technical committee had deemed it advisable to have tests conducted in one laboratory on several boilers of approximately 40-inch grate width, in order to determine whether the provisions of the I-B-R code should be revised in any way so as to obtain results on boilers over 30-inch grate width which he reported as accurate beyond any question.

Tests were conducted with two boilers during the course of the meeting. As a result of the tests, it was decided that the only modification which might improve the code is to tighten up on the analysis of fuel used in tests.

Mr. Johnson discussed the effect of the type of fuel used upon the test results that would be obtained, and suggested that the specific gravity of the fuel should be used as one of the specifications when ordering coal for test purposes.

Dr. Rose discussed some of the characteristics of anthracite that would affect the results obtained during tests. He pointed out that the percentage of volatile matter affects the pickup and is tied in closely with the specific gravity of the fuel.

After Dr. Rose and Mr. Johnson concluded their discussion, Mr. Magos appointed the chairman of the sub-committee to cooperate with Dr. Rose, Dr. Johnson, and Mr. Johnson to work out a revised specification for the fuel to be used in conducting I-B-R tests. After these specifications are completed, the subcommittee is to work out revisions of paragraphs 6 and 7 in part II of the code.



Engineering representatives of manufacturers of cast iron boilers and radiators who met at Johnstown, Pa., to discuss boiler test codes.

Mather Heads Fuel Committee

PHILADELPHIA — Harry H. Mather, president of the Philadelphia chapter, ASHVE, has been appointed chairman of a committee formed by the Philadelphia Council of Defense, to act in an advisory capacity to the council, and to furnish free advice and information to fuel oil consumers on the heating of houses this winter. The headquarters of the committee, which is to be known as the Fuel Committee of the Defense Council, will be in the Broad Street Station Building.

The members of the committee include: Lee Hines, president of the Engineers Club; Merle Blanken, of the ASHVE; Allen J. Johnson, director of Anthracite Industries Laboratory; John Lamond, president of the Master Plumbers Association; Victor Uhl, of the Atlantic Refining Co.; J. P. Rudisell, secretary of the Air Conditioning, Heating & Plumbing Employers Association; and Lionel Jacobs, chairman of the oil burner division, Electrical Association of Philadelphia. R. A. Protheroe, of the Defense Council, will be the executive secretary of the committee.

Warm Air Men to Celebrate 25th Year of Research

CLEVELAND — The National Warm Air Heating and Air Conditioning Association, which will hold its annual convention at the Hotel Cleveland here Dec. 8-9, will celebrate at that time the silver anniversary of its warm air research program in cooperation with the University of Illinois. Dr. Arthur C. Willard, president of the University, will be the guest speaker. He will talk on the developments in warm air heating since the time in 1917 when the research program was begun.

In addition to Dr. Willard, Professors A. P. Kratz and S. Konzo, also of the University of Illinois, will present papers on recent developments in the association's research program. Other speakers will ininclude W. G. Wise, I. L. Jones and Allen W. Williams, the last having formerly been managing director of the Association and who has been writing a history of the Association.

Giesecke Joins Illinois Staff

URBANA, ILL.—Dr. E. E. Giesecke, professor, author, and former president of the ASHVE, has joined the staff of the Engineering Experiment Station of the University of Illinois as a special research professor in mechanical engineering, cooperating in the research projects relating to hot water and steam heating. Dr. Giesecke will be at Urbana for a six months' period.

The Institute of Boiler and Radiator Manufacturers and the ASHVE are both sponsoring hot water and steam heating research projects on which Dr. Giesecke will act as consultant.

Dr. Giesecke was on the staff of the University of Texas from 1912 to 1927 and with Texas A and M College from 1886 to 1912 and 1924 to 1939. He is the author of "Design of Gravity Circulation Hot Water Heating Systems," and a series of articles on "Radiant Heating," and co-author of "Technical Drawing."

Holyoke Girls Are Heat Cops

SOUTH HADLEY, MASS. — "Heat Cops" at Mt. Holyoke College played a big part last winter in saving 26,159 gallons of fuel oil. They are to be on the job again this fall and winter, the students being assigned in rotation to close dormitory windows at 5:45 a.m. each day to conserve fuel.

Heating and Ventilating Engineers Win $5500 in Contest to Show Welding Progress and Savings by Welding

CLEVELAND—Heating and ventilating men figured prominently in the awards announced October 6 in the nationwide 2½-year $200,000 scientific welding study program sponsored by The James F. Lincoln Arc Welding Foundation of Cleveland.

The 2½-year welding study, known as the $200,000 Industrial Progress Award Program, brought forth reports of welding progress prepared by executives, engineers, designers, architects, production officials and others throughout the industrial field. The study indicated a possibility of tremendous savings in costs and man hours for production of products by arc welding for both war and peace.

In the heating and ventilating industry, amounts of the chief awards, the names, subjects and connections of awardees are as follows:

$1,500, George W. Meek, conservation consultant, Syracuse, New York. Subject matter: Skyscraper air conditioning with arc-welded conduit. This paper covered the welding of the Carrier conduit system, an article describing which Mr. Meek wrote for HEATING AND VENTILATING in July, 1941. Number 18 gauge metal is used. At first, difficulties were experienced in obtaining this size metal in conduit form and also in welding it. In his prize paper, the author gives the advantages of the conduit form over the duct form: increased floor space, saving in floor length, increased length of life, reduced fire hazard. The savings per unit is given as 26% over the duct system.

$1,300, John F. Muller and Gonzalo C. Munoz, sales engineer and secretary treasurer, respectively, The American Pulley Company, Philadelphia. Subject matter: A study of the best method of suspending the compressor of a railroad car air-conditioning system. Cast iron was first considered and discarded because of the possibility of hidden defects and space limitations. Cast steel was prohibitive on account of its cost. Detailed accounts of the design of both arc welded and riveted compressor suspensions, together with close stress analysis of the frame, are given. Weight and cost data on both systems indicate the advantages of arc welding, savings in amount of $17.11 per unit and hence, $51,330 per 3000 cars per annum being figured.

$1,300, S. Arnold Smith, chief engineer, The Whitlock Mfg. Company, Hartford, Conn. Subject matter: Developments in the design of heat exchangers with particular reference to storage water heaters. The design and production of heat exchangers and pressure vessels have been simplified and improved by the use of arc welding. The writer developed a method of producing welding neck flanges to meet storage heater requirements by fabricating them from bar stock. The reduction in cost in favor of welded design is $39.74 or 27½%. The saving by weight of materials is estimated to be 7%.

$700, Hugh T. Monson, plant engineer, The Euclid Road Machinery Company, Euclid, Ohio. Subject matter: Down-draft ventilation for large welded assemblies. Unsuccessful attempts were made to exhaust the smoke-laden air from a large welding shop. Four welding booths, each to accommodate four welders and taking assemblies up to 16 feet wide, were then designed. These are to be of welded construction, and with down-draft ventilation provided by fans which exhaust the air through stacks (42 inches). The cost of the booths is estimated as $2,258 and of the whole installation $11,137. It is believed that 5-10% greater production will result from the improved working conditions.

$250, R. M. Rush and H. A. Pietsch, manager, Industrial Department Machinery Division, and chief engineer, Heater Section, respectively, Dravo Corporation, Pittsburgh. Subject matter: Design and development of a direct-fired unit heater for oil, gas and coal firing, and of large capacity.

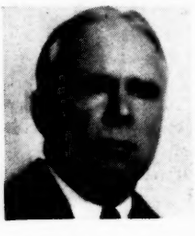
$250, Lemuel J. Harris, manufacturing foreman, Holland Furnace Company, Holland, Mich. Subject matter: Redesigning two parts of a furnace.

$100, William A. McGee, mechanical engineer, The New York Central Railroad Company, Cleveland, Ohio. Subject matter: All arc-welded steam line.

$100, Harry A. Erickson, consultant, mechanical engineer, Baltimore. Subject matter: Assembly of all factual data pertaining to the design of a low-pressure piping system.

$100, William Simons, Dow Magnesium Corporation Project, Marysville, Michigan. Subject matter: All welded duct for air-conditioning system.

There was a total of 408 awards going to 438 participants.



SOME OF THE INDUSTRIAL PROGRESS AWARDS

Left, George W. Meek; center, Gonzalo C. Munoz; right, John F. Muller

Smoke-Screen for Day Blackout

BOSTON—Comprehensive plans for a daytime "blackout" of the Greater Boston area through a gigantic smoke screen to be produced by the public utilities, industrial plants and even householders of the metropolitan area, are being studied by the Army and the Commonwealth, and a test daytime smoke pall may be turned loose on an early date to demonstrate its effectiveness.

This was disclosed at a recent meeting by Lieutenant-Colonel James W. H. Myrick, director of smoke abatement division, Massachusetts Department of Public Utilities. He was addressing a joint meeting of the Boston Society of Civil Engineers and the Boston Post of the Society of American Military Engineers.

Colonel Myrick declared he already has made a comprehensive canvass of State and municipal, industrial and public utility plants throughout the metropolitan district, and his plan includes not only every public and private enterprise with coal or oil furnaces and fires, but would include individual householders on a wholesale scale following intensified newspaper and radio education.

While such lofty spires as the Bunker Hill monument and the Custom House tower could not be obliterated in the proposed smoke screen, the Charles River and other inland water landmarks, and a portion of the inner harbor, could be effectively screened to make bombing of the greater city decidedly inaccurate.

For the individual householder, housewives will be instructed at a given signal to throw oil soaked rags, dirt, even pieces of tar paper, on their furnace and kitchen fires to add to the smoke pall.

Oil-Coal Mixture Proposed for Industrial Boiler Use by Bureau of Mines to Offset Oil Shortage

WASHINGTON — Mixing of oil and coal to produce a liquid fuel suitable for use in many industrial oil-burning boilers has been suggested by the Bureau of Mines as one possible means of alleviating the current fuel oil shortage in the Eastern Seaboard States.

Dr. R. R. Sayers, Director, has informed Secretary of the Interior Harold L. Ickes that the Bureau, in cooperation with oil and coal companies, has for several months been studying the use of this type of fuel and "it appears that the problems can be solved."

On the basis of a preliminary investigation, the Bureau believes that many industrial furnaces could utilize this oil-coal fuel without material alterations in boilers and burners, Dr. Sayers said, and estimated that certain types of furnaces probably would save 30 to 35% of the oil ordinarily consumed.

The Bureau recommends, Dr. Sayers said, that a survey be made of all oil-burning plants on the East coast and that an intensive investigation be conducted into the preparation and burning of this composite fuel. However, the success of the plan, Dr. Sayers pointed out, depends on certain undetermined factors, one of which is to obtain the necessary pulverizing machinery to grind the coal before it can be mixed with the oil.

The first public announcement of the Bureau's current work in this field was made at St. Louis, Mo., on October 1, at a fuels conference held in conjunction with a regional meeting of the American Institute of Mining and Metallurgical Engineers. Dr. W. C. Schroeder, assistant chief of the Bureau's Fuels and Explosives Service and who is in charge of the oil-coal fuel technologic studies, presented a paper on the "Use of Mixtures of Oil and Coal in Boiler Furnaces."

At the present time, the Bureau considers as the most feasible plan one which contemplates the mixing of pulverized coal and oil in a central plant, from which the composite fuel would be delivered to industrial consumers just as fuel oil is now delivered. The consumers could use the fuel without altering their oil burners or furnaces, the Bureau believes, and this feature makes the plan particularly attractive, since no copper, steel or other vital materials would be needed to convert existing equipment. If an oil shortage forced these plants to install stokers or pulverized coal in all their furnaces, it would create a heavy demand for steel and other metals, it was shown.

Reviewing former investigations of the oil-coal problem, especially during 1917 and 1918 in connection with an organization of American shipping, insurance and oil companies known as the Submarine Defense Association, the Bureau pointed out that the chief problem in blending oil and coal into a suitable fuel consists of keeping the coal particles from settling to the bottom of the tank and preventing the mixture from clogging tubes and burners during combustion.

"Furnaces designed exclusively for oil may have relatively small combustion space, small gas passages, and no means for removing ash from the furnace," according to the paper presented by Dr. Schroeder. "Here the mixing of coal with oil must be done with care, for the combustion of the oil may be completed in the furnace while unburned coal particles reach the boiler tubes. The small gas passages may be plugged by coal and ash, particularly if the ash has a low fusion temperature."

In preparing a composite fuel, the Bureau recommends using a bituminous coal which has low ash with a high fusion temperature. Grinding as fine as possible will help to secure rapid combustion, and the use of a tar to keep the coal particles suspended in the oil "may be helpful." It may also be necessary to provide some means (probably by hand) for periodically removing the ash from the bottom of the furnace. Finally, the Bureau states that it may be impossible to operate a boiler at the same high rating as that attained with oil, as this will depend upon the combustion space, the size of the gas passages, the amount of ash in the coal, and the fusion temperature of the ash.

"Although the magnitude of these difficulties cannot be overlooked if a shortage of fuel forces a change in operation, probably they are not so great as might be experienced in installing pulverized fuel or stokers," Dr. Sayers said in commenting on the investigations.

In recommending a survey of oil-burning plants on the Eastern coast, the Bureau believes that this should be conducted to determine the following facts:

(1) If they already have the necessary equipment to burn coal;

(2) If coal-burning equipment could be installed without rebuilding the furnace and boiler;

(3) If an oil-coal fuel could be used without seriously reducing the boiler rating; and

(4) If the boiler would be plugged by the ash from oil-coal mixtures.

In the first case, the plants must burn coal if they have not already begun to do so; in the second, oil-coal fuel might be used until coal-burning equipment could be procured; in the third, the composite fuel would help to conserve oil without interfering with operation; while in the fourth, the boiler furnace would have to continue on oil or be shut down.

Power Show Completes Transfer

NEW YORK—Continuously increased interest in recent weeks proves the 15th National Exposition of Power and Mechanical Engineering to be fulfilling many new-found needs. Transfer of the Exposition to its new location in Madison Square Garden has been successfully accomplished.

The Exposition is to be held November 30 to December 4 in the Exposition Hall of the Garden, which has the advantage that it permits all exhibits to be staged on one floor. A special entrance has been provided through a new lobby on 49th Street, just West of Eighth Avenue, giving separate and direct access to the Show at all times.

Maine Houses Convert to Sawdust

FARMINGTON, ME. — Sawdust burning units for home heating have replaced oil and coal furnaces in 150 buildings surrounding sawmills in Maine. Residents have converted to the sawdust burners and according to users these units heat homes and factories for less than half the cost of oil. The burners are simple Dutch oven type furnaces which utilize thermostats to maintain an even temperature. Grates are removed from regular furnaces for conversion and a sawdust burner attached to the ash pit door.

Britain Begins Heating Nov. 1

LONDON — The British Ministry of Fuel announced late in September that central heating may not be used until after Oct. 31, unless, of course, a cold snap sets in, causing a short notice change in the plan.

The Ministry made clear that the ban will not apply in hospitals or industrial premises or houses with less than 10 furnished rooms. Hotels, blocks of flats and large houses will be the most extensively affected.

Since some parts of Great Britain are much colder than others, the starting up of central heating may be decided upon by meteorologists.

Industrial Degree Days

The degree-day for fifteen years or more has been in increasing use as a guide to operating efficiency and for predicting fuel consumption in buildings maintained at or near 70F. There has not been, however, a wide application of the industrial degree-day for industrial or other buildings where considerably lower (then 70F) temperatures are maintained. This unit, calculated on both a 55F and 45F basis, for inside temperatures of 60F and 50F, was originally proposed in the first edition of The Degree-Day Handbook in 1930.

With the thought that continued publicizing of

Month	CITIES									
	Baltimore	Buffalo	Chicago	Cleveland	Detroit	Indianapolis	New York	Philadelphia	Pittsburgh	St. Louis
Number of Industrial Degree-Days, 55F Base										
1938										
September	0	9	12	4	9	4	0	0	4	1
October	14	132	60	81	128	61	29	12	54	21
November	222	395	388	315	391	333	273	253	304	268
December	481	735	797	664	767	644	553	541	606	575
1939										
January	528	891	729	696	843	596	703	636	601	454
February	381	775	771	639	788	614	499	446	519	578
March	339	765	551	563	672	389	501	421	433	285
April	143	479	345	331	364	224	233	193	236	165
May	12	91	55	53	60	18	21	16	32	1
Total 1938-39	2120	4272	3708	3346	4022	2883	2812	2518	2789	2348
1939										
September	0	18	11	6	17	7	0	0	0	3
October	55	167	124	119	175	93	92	77	106	58
November	243	512	399	396	488	373	354	305	372	295
December	442	704	620	593	670	588	577	526	555	486
1940										
January	898	1144	1201	1100	1121	1185	929	917	1071	1169
February	508	873	748	768	820	660	640	587	660	609
March	466	867	712	753	818	547	623	544	605	410
April	155	452	330	377	377	205	272	207	236	134
May	6	138	128	99	92	59	5	2	50	29
Total 1939-40	2773	4883*	4273	4211	4578	3717	3492	3165	3655	3193
1940										
September	4	22	10	16	24	10	5	3	10	0
October	97	235	30	121	157	31	142	126	112	4
November	229	476	496	405	507	415	311	273	358	360
December	376	686	658	567	711	537	500	454	453	470
1941										
January	630	948	835	787	894	736	779	720	735	610
February	586	877	824	796	831	753	661	649	749	624
March	461	893	708	758	758	577	598	546	673	440
April	41	218	177	197	170	64	98	54	75	34
May	3	89	40	43	37	19	7	3	26	0
Total 1940-41	2427	4444	3778	3690	4089	3142	3101	2828	3191	2542
1941										
September	0	9	5	4	7	0	0	0	0	3
October	25	139	70	87	93	37	42	26	50	36
November	141	350	369	315	370	304	184	174	280	266
December	396	659	559	518	602	513	524	472	487	431
1942										
January	595	954	887	825	903	795	746	698	721	697
February	575	954	796	829	906	736	713	653	747	588
March	251	583	477	565	510	349	370	320	370	281
April	72	291	180	181	200	114	137	106	141	75
May	0	79	53	27	48	22	6	0	1	6
Total 1941-42	2055	4018	3396	3351	3639	2870	2722	2449	2797	2383

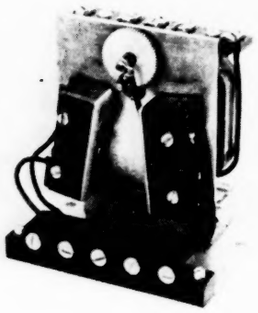
*Including 8 for June.

(Continued on next page)

this unit might result in its wider and possibly beneficial use, HEATING AND VENTILATING begins with this issue publication of industrial degree-day data for ten cities. Each month through the heating season, monthly industrial degree-day figures for these cities will appear. The accompanying tables are, in a way, laying the groundwork for such monthly figures, since these tables cover the preceding four heating seasons, so that the reader has comparative data. Next month the industrial degree-days, 45F and 55F, for these same ten cities for the month of October, will be published.

Month	CITIES									
	Baltimore	Buffalo	Chicago	Cleveland	Detroit	Indianapolis	New York	Philadelphia	Pittsburgh	St. Louis
	Number of Industrial Degree-Days, 45F Base									
1938										
September	0	0	0	0	0	0	0	0	0	0
October	0	5	8	1	11	4	0	0	0	1
November	97	201	177	143	188	153	119	109	135	124
December	189	428	492	360	457	341	271	244	303	292
1939										
January	256	581	406	407	535	317	401	346	320	221
February	148	495	465	379	509	345	239	202	275	307
March	109	460	281	290	391	153	225	164	184	103
April	11	214	125	117	141	59	48	33	67	43
May	0	12	3	5	4	0	0	0	0	0
Total 1938-39	810	2396	1957	1702	2236	1372	1303	1098	1284	1091
1939										
September	0	0	0	0	0	0	0	0	0	0
October	1	35	22	12	39	15	4	1	9	8
November	43	224	141	137	204	128	95	70	113	81
December	174	399	319	305	362	304	282	238	280	256
1940										
January	588	834	891	790	811	875	619	608	761	859
February	224	583	458	478	530	370	350	298	372	320
March	195	560	428	458	517	290	324	258	327	187
April	23	184	90	140	116	51	57	36	61	23
May	0	18	28	15	16	14	0	0	4	5
Total 1939-40	1248	2837	2377	2335	2595	2047	1731	1509	1927	1739
1940										
September	0	0	0	0	0	0	0	0	0	0
October	17	78	0	15	18	0	23	23	21	0
November	54	222	245	177	250	190	98	78	147	158
December	107	387	338	275	402	237	207	167	187	195
1941										
January	322	638	515	478	584	429	469	410	429	310
February	306	597	544	520	551	476	381	369	473	353
March	176	583	398	451	448	279	291	242	369	174
April	0	49	38	39	33	0	1	0	1	0
May	0	0	0	1	0	0	0	0	0	0
Total 1940-41	982	2554	2078	1956	2286	1611	1470	1289	1627	1190
1941										
September	0	0	0	0	0	0	0	0	0	0
October	1	19	12	11	17	3	1	0	1	6
November	19	110	142	107	129	121	29	26	80	103
December	140	376	280	256	314	261	249	202	229	199
1942										
January	307	644	589	518	593	488	442	397	426	413
February	298	674	516	549	626	456	433	374	470	318
March	35	286	191	191	213	123	83	60	115	82
April	5	99	47	53	62	20	21	14	30	12
May	0	1	1	0	0	0	0	0	0	0
Total 1941-42	805	1535	1778	1685	1954	1472	1258	1073	1351	1133

NEW EQUIPMENT

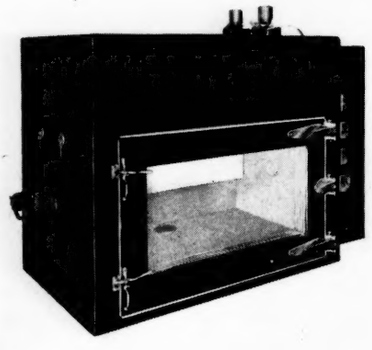


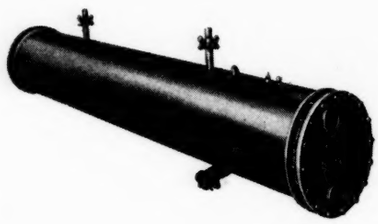
Motorelay

NAME—Barber-Colman Motorelay.
PURPOSE—Used with any floating contact device in applications where the control current exceeds the contact rating of the control instrument.
FEATURES—Improved in construction, the new Motorelay includes a shaded pole, reversible geared head motor, totally enclosed switches in place of mercury tubes, and a new simplified switching mechanism. An enclosed type drawn steel cover is available.
SIZES AND CAPACITIES — Switch contacts have a non-inductive load capacity of 10 amperes at 110 or 230 volts ac. Control circuit current is 0.35 at 25 volts.
LITERATURE AVAILABLE—Bulletin A-20 or Catalog F-1753.
MADE BY — *Barber-Colman Company, Rockford, Ill.*

Instrument Tester

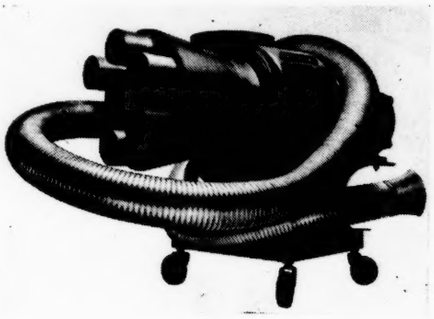
NAME—Model RTC-1 low and high temperature test chamber.
PURPOSE — For the testing of industrial instruments under extremes of cold and heat.
FEATURES—Consists of a two-stage condensing unit, heat exchanger, liquid sub-cooler, coil evaporator, expansion valves, cabinet and forced draft strip heater with thermostats and other controls and connections for each. The all-steel cabinet has a 51½ by 26 in. high door in which is a window of five thicknesses of glass with a visible opening 46 in. wide by 21½ in. high. Temperature conditions anywhere between —67F and +154F can be maintained automatically. Refrigerant is maintained in the cooling coil at a definite pressure and temperature controlled solely by a pressure switch, and cabinet temperature is maintained by control of the recirculation of air within the cabinet and over the coil. Automatically operated dampers control the portion of air passing over the coil. A lowering in temperature from room conditions to —58F in approximately one hour, is claimed.
SIZES — Overall cabinet dimensions 83 in. wide by 56½ in. high by 42 in. deep. Cubic content is 28.7.
MADE BY — *American Coils, Inc., 25-27 Lexington Street, Newark, N. J.*





Freon Condenser

NAME — Type CW-80 water cooled freon condenser.
PURPOSE — For cooling and condensing freon after compression.
FEATURES—Unit consists of a seamless steel shell with steel tubes and with a removable cast iron header which can be arranged for either series or parallel water flow. Tubes are rolled into tube sheets and soldered to insure permanently tight freon joints. Manufacturer claims finless construction permits removal and replacement of tubes if necessary. A ball type valve provides for purging non-condensable gases and condenser has a fusible plug with melting point of 230F. Condenser conforms with ASME boiler construction code for unfired pressure vessels. Each unit tested at 300 lb per sq in., cleaned and dehydrated, then filled with dry inert gas at 30 lb pressure before being sealed and shipped from factory.
SIZES—Units built in sizes from 5 to 100 tons each, net refrigeration effect.
MADE BY—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

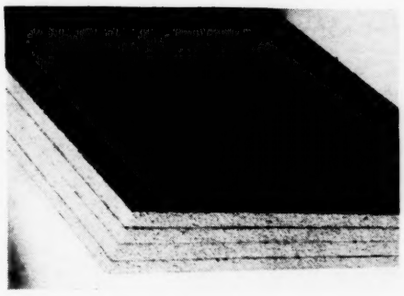


Exhaust Unit

NAME—The Octopus exhauster and ventilator.
PURPOSE — For miscellaneous exhaust and ventilating applications, especially for ship holds, mines, sewers, tunnels, and factory welding departments.
FEATURES — Consists of a direct motor driven centrifugal blower, with a blower wheel of new and special design, and with the unit mounted on a low base fitted with casters. Blower has a special inlet adapter equipped with six suction hose connections. From one to six different localities can be ventilated simultaneously by use of proper hose connections. Caps are provided for openings not in use. The unit is powered by a heavy duty ball bearing motor equipped with overload protection and can be placed or hung in any convenient place between the working area and the open air. Unit can easily be converted into a fresh air ventilator by simply changing the position of the tube adapter.
MADE BY — *Chelsea Fan & Blower Co., 1206 Grove St., Irvington, N. J.*

Lever-Seald Plug Valves

NAME—Lever-Seald plug valves.
PURPOSE—For typical valve applications in piping systems.
FEATURES — Made in either semi-steel or steel, this new line of plug valves has face-to-face dimensions the same as those of corresponding sizes of wedge-gate valves. This makes them completely interchangeable with the latter without changes in piping. The company's traditional quarter-turn operation, and a powerful leverage to provide positive easy opening or shut-off, has been incorporated.
SIZES—From 1½ in. to 10 in., for working pressures up to 150 lb.
MADE BY—*Homestead Valve Manufacturing Co., Inc., Coraopolis, Penna.*

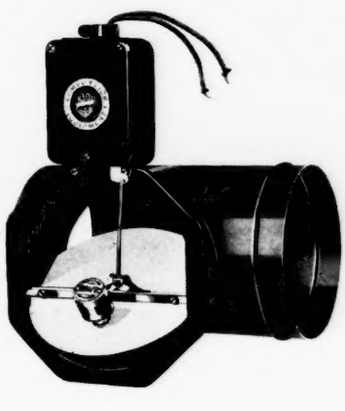


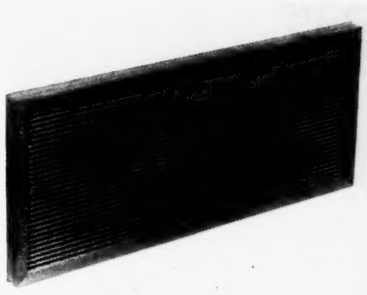
Sugar Cane Insulating Board

NAME—Celo-block insulation.
PURPOSE — For general insulating purposes, as a substitute for cork.
FEATURES—Made from sugar cane fibres of selected lengths and thicknesses, woven and felted into ½ in. boards of a low density, this new material is claimed to be equal to corkboard, besides being cheaper and stronger and unlimited in source of raw materials. Individual fibres before being felted into boards are sterilized, water-proofed, and protected from dry rot and fungus growth by the patented Ferox process, after which the boards are laminated together with asphalt cement, and the edges coated. Product has a thermal conductivity of 0.30 Btu per in. per sq ft per hr per F and is applied in the same manner as corkboard.
SIZES AND CAPACITIES — Three standard thicknesses, 1½, 2 and 3 in. and in sheet sizes of 18 in. by 18 in. and 18 in. by 36 in.
MADE BY—*Celotex Corporation, 919 N. Michigan Avenue, Chicago, Ill.*

Draft Regulators

NAME—Models B and BM Draft-O-Stats.
PURPOSE — For regulating heating plant drafts.
FEATURES—Model B is a barometric control consisting of a balanced counterweight metal air valve of welded steel construction, die stamped and finished in red and black baked enamel with polished fittings and adjusting mechanism. May be used on automatic as well as hand-fired installations. Model BM is standard model B with the addition of an electric controlling motor. It can be used on automatically controlled hand-fired plants, the thermostat opening and closing the regulator and thus regulating heater draft and heat output. To prevent backing up of smoke into furnace room during firing periods a manual switch may be installed to permit closing of regulator, this being recommended for bituminous coal only. On automatic installations model BM acts not only as a barometric control but also automatically checks the draft setting and saves fuel by opening the flutter wide during the cut-out period. No additional wiring needed with model BM when used in conversion work since it will operate from the existing oil burner circuit.
SIZES—Model 6B or 6BM for 6 and 7 in. flue pipes; model 9B or 9BM for 8, 9, and 10 in. flues. Motor either 110 or 24 volt as specified.
MADE BY—*The Hotstream Heater Co., Combustion Equipment Division, 8007 Grand Avenue, Cleveland, O.*





Sight-Tite Grille

NAME—Uni-flo Sight-Tite grille.
PURPOSE — For fresh air inlet or exhaust ventilation, in doors, walls, panels, and baseboards.
FEATURES — Consisting of overlapping v-shaped fins, and with diffusers on the edges of the fins which add rigidity and improve the appearance, this grille is proof against the penetration of light, according to the manufacturer. When used in outside walls for the inlet of fresh air, it is claimed to be an effective barrier against rain or snow.
SIZES AND CAPACITIES—In units up to 36 in. by 36 in. Larger sizes prefabricated in two or more sections and assembled into a common frame.
LITERATURE AVAILABLE—Bulletin F-1901.
MADE BY — *Barber-Colman Company, Rockford, Ill.*

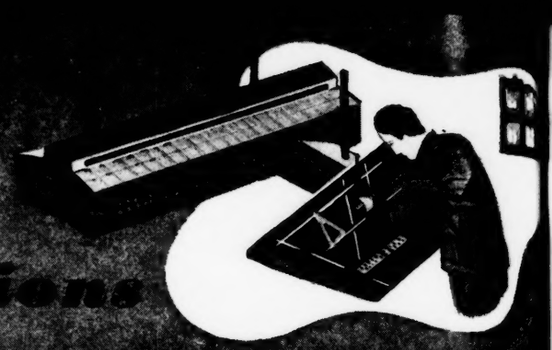
Wood Roof Ventilator

NAME—Breidert B-W Air-X-Hauster.
PURPOSE—To replace metal ventilators for ventilation of industrial buildings.
FEATURES—Made of kiln dried California Redwood of 8% moisture content, this duplicate of the company's previous sheet metal types of ventilators is said to be very resistant to weather, light in weight, and of rigid construction. In performance it is stated to be equal in all respects to the metal types. The top and bottom plates are made of 1 in. laminated boards securely glued together and the outer and inner walls are set in routed grooves filled with weather-proof glue. Top and bottom are held together with tie rods, the entire construction being stronger than if made of sheet metal, manufacturer states. One-half inch mesh galvanized bird screens can be fastened over the openings if desired. The entire assembly is treated with boiled linseed oil to provide a base for paint. Available in two types, B2-W equipped with metal steeple and B-W with flat top.
MADE BY—*G. C. Breidert Co., 3328 Central Avenue, Los Angeles, Calif.*

Temperature Sensitive Lacquer

NAME—Tempilaq°.
PURPOSE — For indication of surface temperatures.
FEATURES — Tempilaq° is applied as a smear or daub to any working surface. The lacquer dries instantly on warm surfaces and the resulting smear liquefies sharply when the melting temperature is reached. On cooling it solidifies and leaves a glossy mark different from the original smear. Available in a range of melting points between 125 and 1600F.
MADE BY — *Tempil° Corporation, 132 West 22nd St., New York, N. Y.*

REVIEWS of TECHNICAL publications



SUN HEAT

"Artificial Converters of Solar Energy," by H. C. Hottel. Included in the Annual Report of Smithsonian Institution—1941. Available from Supt. of Documents, Washington, D. C. Price, $2.

Although progress is slow, utilization of the sun's heat may eventually be practical on a large scale. The work of Dr. C. G. Abbot of Smithsonian Institution developing a solar heating machine has been well publicized; solar heating of service water in semi-tropical regions such as Florida is quite common. At the annual meeting of the American Gas Association in October, the president of the East Ohio Gas Company, in forecasting possible post-war competitors of gas heat said: "That the sun's heat itself may compete with us practically instead of just seasonally as now, by depriving us of our house heating load part of the year, is entirely possible."

Research on utilization of solar energy has been under way at Massachusetts Institute of Technology for some years under an endowment by Dr. Godfrey Cabot. In discussing this work, H. C. Hottel, of M. I. T., writing in the annual Smithsonian report, states that a flat plate solar energy collector could furnish all but 15% of the energy necessary for house heating in New England; the 15% would have to be supplied in December, January, and February.

In his paper which originally appeared in the Sigma Xi Quarterly, Prof. Hottel reviews other possible methods of utilizing solar energy, such as taking advantage of the phenomenon of photoelectricity, so that the resultant energy would be electrical, a far higher form of energy than heat. Another method, also under investigation at M. I. T., and mentioned by the author, is a photochemical process, analogous to the energy conversion process in plants, which receive sun energy and convert it to carbohydrates.

This paper is only a small part (12 pages) of the complete report.

UNIT HEATER STANDARD

"Standard Code for Testing Hot Water Unit Heaters," Published by Industrial Unit Heater Association, 5-208 General Motors Bldg., Detroit, Michigan.

The first printing of this new standard is now available for free distribution to the public. Prepared by the Engineering Committee of the Association, this 12-page, 8 x 11½ in. pamphlet lists the requirements which have been agreed to by member companies and which must be complied with before the IUHA certified rating label may be attached to approved appliances.

LIGHTING

"Lighting and Air Conditioning," by H. M. Sharp. Published by the Industrial Press, 148 Lafayette Street, New York, N. Y., from HEATING AND VENTILATING, November 1942. Price, 25 cents.

This standard size, 12-page pamphlet, printed in maroon ink on 140 lb India tint coated stock, summarizes the relationships existing between lighting and air conditioning and shows how this knowledge will benefit the air conditioning engineer in his design work.

Some of the phases treated cover: sensible heat and lighting; radiant heat; the psychology of color; and cost data.

This pamphlet constitutes HEATING AND VENTILATING's Reference Section No. 7.

BUILDING MATERIALS

"Building Materials and Structures, Report BMS85," Superintendent of Documents, Washington, D. C.

The seven page report BMS85 deals with an investigation on dimensional changes of floor coverings which occur with changes in relative humidity and temperature. The effects of a variation in relative humidity from 8 to 86% and in temperature from 32 to 90F are discussed. The relative humidity effect was found to be much greater proportionately than that due to temperature changes.

The report is paper covered, 8 by 10½ inches. BMS85, price 10 cents.

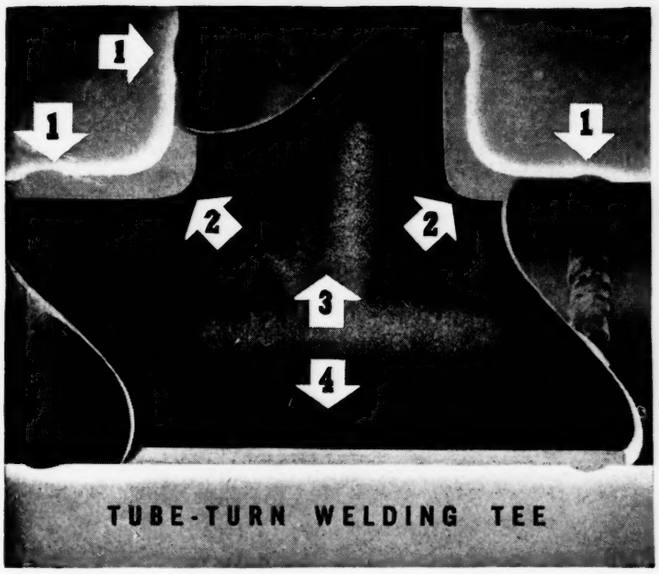
SAVING COAL

"Victory Begins in the Home—Save Coal." Prepared by Office of Price Administration and reprinted by Anthracite Industries, Inc., Primos, Delaware County, Pa.

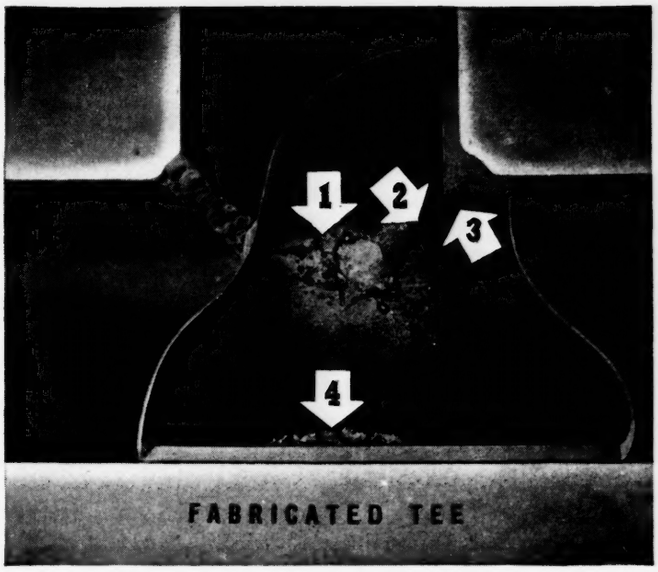
This 12½ by 19 in. furnace room wall chart, prepared by the Office of Price Administration and approved by the Technical Advisory Board of the Anthracite Industry, lists the important points to be checked and precautions to be observed in coal firing in the home in order to secure the greatest possible efficiency. The best firing methods are illustrated by diagrams; and suggestions for economy, convenience, and comfort, as well as rules about domestic hot water heating, are included.

Also available from Anthracite Industries, Inc., is an instruction sheet governing the use of anthracite coal in fireplaces.

Why TUBE-TURN WELDING TEES provide strong, safe, easy-to-weld branch connections



(1) Easy circumferential butt welds cut installation time, make sounder, safer joints. (2) Easy sweeping curves reduce friction and pressure loss to a minimum. (3) Smooth inside walls assure even flow and add to the long life of the connection. (4) No accumulation of slag.



(1) Joining a branch into a main with an intersection weld makes a weaker, less sound connection. (2) Gaps and irregularities caused by uneven cutting must be filled by welder. (3) Sharp corners and jagged angles are poor piping practices. (4) Possible slag accumulation can impede flow and seriously injure valves.

COMPARE the two cut-away illustrations above point by point for *proof* of the unmistakable superiority of welding tees.

It takes *fewer man-hours and far less trouble* to install a Tube-Turn welding tee into a piping system than to fabricate a branch connection, a vital factor in today's plant expansion and modernization for war needs. Other major advantages of these seamless welding tees are the *greater strength, longer life,* and *smooth flow* secured.

The design and construction of Tube-Turn welding tees *add to the strength of the entire piping system* by reinforcing these crucial points.

8 REASONS FOR SPECIFYING TUBE-TURN WELDING TEES

1 *Extra thickness at crotch* reinforces where highest stress occurs.

2 *Reinforcement along top of run* adds needed strength here.

3 *Reinforcement on sides*—also a point of high stress gradually tapers toward end of outlet and bottom of run.

4 *Longer outlet* permits faster lining up and ample room for rod manipulation.

5 *Ends machined* to exact pipe wall thickness—easy to align and weld.

6 *Increased thickness at bottom* adds to full strength without excess weight.

7 *Smooth inside walls, curved inner crotch and special manufacturing process* assure even flow.

8 *Size, material, thickness and name* identified on permanent name-plate.

Tube Turns manufactures a complete line of welding fittings and forged steel flanges in all standard sizes and weights. Write for new complete catalog and valuable engineering data book No. 111. It's free.

TUBE TURNS, LOUISVILLE, KY.
INCORPORATED

Branch offices: New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Tulsa, Houston, Los Angeles, Washington, D. C. *Distributors in all principal cities.*

TUBE-TURN
TRADE MARK
Welding Fittings

COMBUSTION

"Handfiring of Bituminous Coal in the Home," by A. P. Kratz, J. R. Fellows, and J. C. Miles. Published by the University of Illinois, Urbana, Illinois. Price, 25 cents.

Circular No. 46, 6 x 9 in., 36 pages, is intended as a non-technical guide directed to the home owner and outlining the proper method of burning bituminous coal in domestic furnaces and boilers. An improved side-bank method of firing is described, and a new method for the handling of the cheaper sizes of coal, particularly in the nut and slack grades, is outlined in detail.

An instruction chart of a size which can be conveniently placed near the furnace is furnished with the circular.

A limited supply of the circular and chart is available free until April 1, 1943, or until the supply is exhausted, by application to the Engineering Experiment Station, Urbana, Illinois.

HEATING TRENDS

"Trends in Heating Developments." Reprinted from Coal-Heat magazine, 20 West Jackson Blvd., Chicago, Illinois.

In an effort to ascertain long-term trends as accurately as possible and to get some inkling about the probable condition after the war in regard to heating and its allied fields, expresssions of opinion were solicited by the editor of *Coal-Heat*, Mr. K. C. Richmond, from a number of well-informed people connected, in various ways, with the heating industry.

The replies, which originally were published in *Coal-Heat*, July, 1942, have been reprinted in this 4 x 9 in., 48-page pamphlet. The opinions are both very interesting and informative.

HEAT EXCHANGE STANDARD

"Standards of Heat Exchange Institute — Non-Deaerating Heater Section." Published by Heat Exchange Institute, 90 West Street, New York, N. Y. Price, 75 cents.

This new standard, which has been agreed to by member companies, sets forth the nomenclature, definitions, types and standards of construction, rating standards and guarantees, accessories, and typical specifications for non-deaerating direct contact heaters. Several pages of miscellaneous engineering data are included in the 12-page, 8½ x 11 in., paper covered pamphlet.

DISTRICT HEATING

"Proceedings of the National District Heating Association for 1942," published by the National District Heating Association, 827 N. Euclid Avenue, Pittsburgh, Pa., and reviewed in our October, 1942 issue, is priced at $3.00 instead of $5.00, as published.

FUEL CONSERVATION

"Home Insulation with Mineral Products — Conservation of Fuel for War," by Dr. O. Bowles. Published by the Department of Interior, Bureau of Mines, Washington, D. C.

This new information circular No. 7220, written by the Chief of Nonmetal Economics Division of the Bureau, describes insulation products of mineral origin including mineral wool, vermiculite, diatomite, pumice, magnesia, and others, and discusses potential savings possible with their use in the home.

A number of experiments conducted to determine approximate percentage of fuel saved by various insulations are reviewed by the author, these estimated savings ranging from 30 to 40% in most cases.

Copies of this circular available free from the Bureau of Mines, Department of Interior, Washington, D. C.

DEGREE-DAYS

"The Degree Day Temperature Manual" for Maryland and Delaware. Issued by the Maryland State Weather Service, Baltimore.

An excellent 42-page pamphlet by John R. Weeks, State Meteorologist, Baltimore, Md., and including monthly and total normal degree-days for 53 Maryland and 7 Delaware localities, monthly degree-day maps for these states, and tabulated degree-days by months for Baltimore from 1871 to 1941. Essentially the same range of information is included on what the author terms cooling degree-days (above 75F), together with several statistical analyses of heating and cooling degree-days.

No stated price is given; the booklet is apparently available free.

FUEL CONSERVATION

"How to Heat Your Home with Less Fuel This Winter." Obtainable from the Office of the Bituminous Coal Consumers' Counsel, P.O. Box 483, Benjamin Franklin Station, Washington, D. C,

To insure the health and comfort of the public and to promote a widespread realization of the urgent need for fuel conservation during the coming winter, a six-page, 6 by 9 in. pamphlet has been prepared with the following message: (1) Inspect and adjust heating equipment, (2) Insulate walls, and roof or attic, (3) Install storm windows and doors, and (4) Weather strip and seal leaks around windows and doors.

Prepared jointly by Office of Petroleum Coordinator, War Production Board, Office of Price Administration, Bituminous Coal Consumers' Counsel, Office of Solid Fuels Coordinator, and Office of War Information.

This bulletin strongly urges immediate action by householders and other fuel users, and gives in condensed form a number of timely tips as to how best to accomplish the desired results.

TOE-TO-TOE slugging isn't for destroyers. They move in fast, like a lightweight boxer, slam home the depth charges or torpedoes, and speed off.

Speed is the thing. That's why modern destroyers must be stripped of every pound of excess weight—and why lightweight sheet steel is used wherever possible, instead of heavier plates. Sheets are found in a lot of places on board the modern destroyer.

From the light-gage, zinc-coated ventilating ducts to the heavier bulkheads, torpedo tubes, and deck structure, Bethlehem Sheet Steel is out there on the Seven Seas with the U. S. Navy, in destroyers, in P.T. boats, and in heavier fighting ships. In cargo vessels, too.

In fact, in every phase of the war—in mechanized equipment for the Army, in submarine net buoys, in ductwork and roofing in hangars and war factories—Bethlehem Steel Sheets are at work, giving the same good service as in their former peace-time applications.

BETHLEHEM STEEL SHEETS

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY

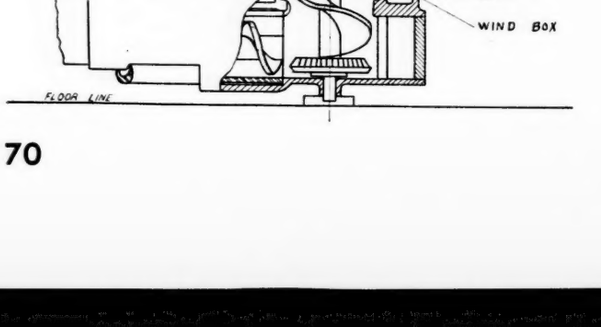
BITUMINOUS COAL STOKER

"Domestic Stoker for Bituminous Coal," by S. Wilson Guthrie. Reprinted from a paper in Mechanical Engineering, August 1942, pages 599 to 603. Single copies, 75 cents.

Coal producers, combustion engineers, and others interested in the utilization of Pennsylvania bituminous coals have, ever since the introduction of the small domestic stoker, been faced with the problem of how to burn this fuel successfully. Most highly coking coals when burned on the conventional type stoker and subjected to long hold-fire periods develop the familiar coke-tree which causes so much trouble from an operational standpoint. The coke becomes so dense that it is impossible to force air through it, which may cause an outage; or, as the process of coke-tree formation continues over a period of several hours, the firebox may be filled with such an accumulation that the system is overloaded.

Investigations carried out at Pennsylvania State College apparently have found a solution to this problem. A paper presented at the semi-annual meeting in Cleveland, Ohio, June 8-10, 1942, of the American Society of Mechanical Engineers, by Mr. Guthrie, research engineer of Rochester & Pittsburgh Coal Company, Indiana, Pa., summed up the findings of these investigations.

Starting with the known fact that coals which ordinarily give much trouble from coke-tree formation will, after approximately a year of storage in the open air, work successfully; also, that crop coals and coals from the central west, both of which have a higher oxygen content than the Pennsylvania bituminous types, all work successfully in the small stoker without coke-tree formation; it was reasoned that preoxidation of coke-forming coals might render them suitable for small stoker use. This conclusion was borne out in the subsequent tests with the especially adapted stoker illustrated. This is a phantom view of a converted domestic stoker which has been operating satisfactorily for more than a year. The unit, as originally purchased, had an automatic ash removal feature built into it and the only changes necessary to convert it to the preoxidation principles were: (1) The installation of the vertical screw; (2) Use of a beveled gear at the base of the vertical screw shaft, sized to give a speed ratio for the vertical shaft of two and one-half times that of the horizontal feed screw; (3) The design and installation of a ring of preoxidizing tuyeres located approximately 6 to 8 in. below the active burning zone. These admit air into the coal as it feeds upward toward the burning zone; (4) A device to keep these tuyeres open. It was found that after two or three days these ports became packed with fine coal, thus decreasing the amount of preoxidizing air and resulting in coke formation which caused typical coke-tree troubles. That these changes were successful, insofar as the elimination of coke formation was concerned, was brought out conclusively in the tests. The actual behavior of the coal in the stoker was substantiated by standard British coke-button swelling tests which showed a remarked reduction in swelling tendencies. The tests definitely showed that as the air is continuously and intimately mixed with the coal, while the coal approaches the burning zone and undergoes a temperature rise, sufficient oxidation takes place to result in the elimination of coke-tree formation and greatly improved operation.



REFRIGERATION STANDARD

"Recommended Commercial Standard for Commercial Electric Refrigeration Condensing Units—TS-3350." Published by the U. S. Department of Commerce, National Bureau of Standards, Washington, D. C.

This recommended standard as adopted by the Manufacturers' Conference of June 23, 1942, and revised to suit subsequent composite comment, is being circulated to producers, distributors, and users for written acceptance as a basis for publication by the National Bureau of Standards.

The proposed standard covers requirements of air-cooled and water-cooled belt-driven commercial units from 1/5 to 3 hp in size, and water-cooled units of 5 hp, using methyl chloride, freon 12, or sulphur dioxide refrigerant.

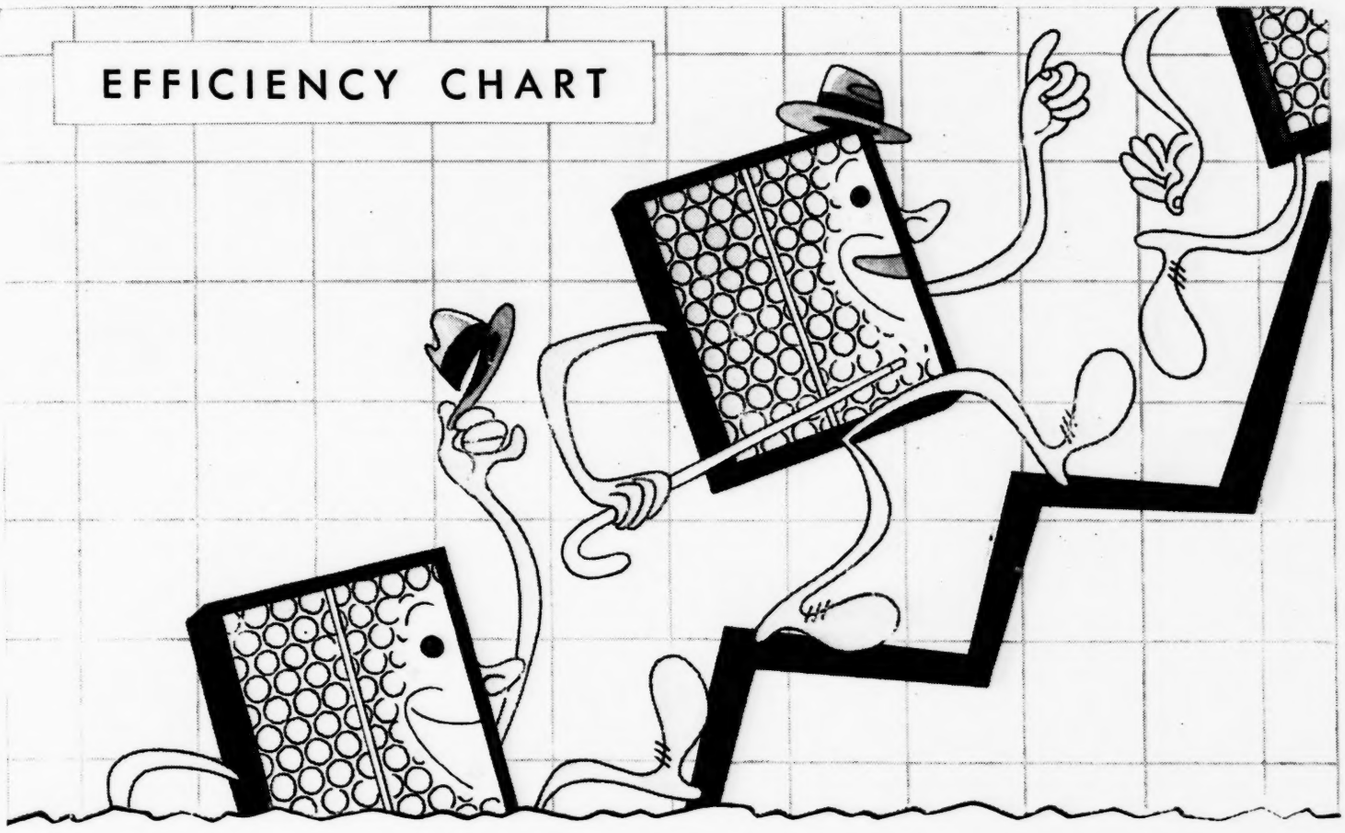
All applications including air conditioning are covered, as are also the minimum requirements for controls, shut-off valves, and receiver tank capacities.

FURNACE STANDARDS

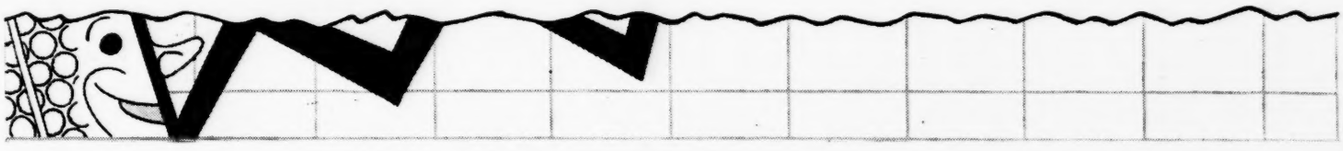
"Recommended Commercial Standard for Warm Air Furnaces Equipped with Vaporizing Pot-type Oil Burners, TS-3333." Published by the U. S. Department of Commerce, National Bureau of Standards, Washington, D. C.

This recommended Standard follows an earlier draft covering the same subject sent out to solicit constructive comment, and it has been adjusted to suit the composite recommendations resulting therefrom. It is being widely distributed to users, distributors, and producers of vaporizing pot-type, oil burning warm air furnaces, with a request that approval be indicated if the provisions of the standard are acceptable.

The Standard consists of 30, 8½ by 11 in., mimeographed pages.



AIR CLEANERS THAT STEP UP PLANT EFFICIENCY



TODAY, when many plants are operating on 24-hour schedules . . . when special emphasis is being placed on plant efficiency, the advantages of Fiberglas* Dust-Stop* Air Filters become of even greater importance.

For Dust-Stops eliminate virtually all nuisance dusts, dirt, and pollen from the air. They help prevent dust spoilage of delicately-machined parts. They aid dust control in paint spraying and precision assembly processes. They contribute to more healthful working conditions . . . in fact, an all-around stepping up of plant efficiency.

Fiberglas Dust-Stop Air Filters are now serving many of America's essential war industries including aircraft and engine plants, steel and textile mills, factories producing precision instruments.

Look over these outstanding Dust-Stop Advantages

Performance: Dust-Stop capacity is 2 CFM per sq. inch of area at 300 FPM. Average resistance, new, in inches of water gauge: .065 for the 1-inch, .13 for the 2-inch.

Economy: These filters cost only 1c per CFM for original equipment, and less than 1/10th of 1c per CFM to replace. Further savings are obtained by reusing filters after gently tapping out or vacuum cleaning.

Easy to Change: It's no job to change Dust-Stop Air Filters. Anyone can replace old filters with new Dust-Stops in a jiffy.

Fire-Safety: Dust-Stop Filter packs are glass . . . the individual fibers CAN'T burn. The adhesive is non-combustible. Dust-Stops have been tested and approved by Underwriters' Laboratories Inc.

Availability: Made from materials which are abundant and easily available right here in this country.

Dust-Stop Filters are available in standard filter sizes. They come in two thicknesses—No. 1 (1 inch thick), No. 2 (2 inches thick). Ask your leading air-conditioning manufacturer, distributor, or dealer about them. If they can't supply samples, prices, and complete information, write to us today.

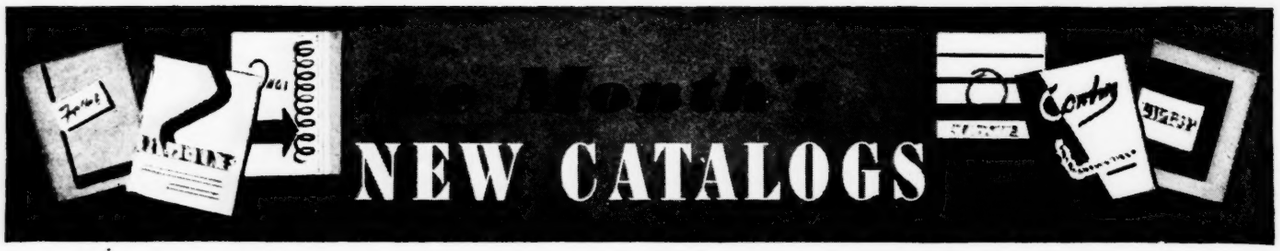
FIBERGLAS*

DUSTOP*

AIR FILTERS

*T. M. Reg. U. S. Pat. Off.

Owens-Corning Fiberglas Corporation, Toledo, Ohio. In Canada, order from Fiberglas Canada, Ltd., Oshawa, Ontario.



FUEL SAVING

Minneapolis-Honeywell Regulator Company
Minneapolis, Minn.

A new 32-page, 4 in. by 5 in., mailing pamphlet which lists 20 important rules governing the proper operation of heating plants and the saving of fuel. Suggestions cover use of wood, oil, gas, and coal for heating.

V-BELTS

Allis Chalmers Mfg. Company
Milwaukee, Wisconsin

A 16-page, 5 x 7 in. booklet entitled "Plain Facts on Wartime Care of Rubber V-Belts." Contains no advertising and applies to all makes of V-belts.

PLYWOOD

Douglas Fir Plywood Association
Tacoma, Washington

Two new, 9 x 12 in., cloth covered loose-leaf binder handbooks give new uses and data for fir plywood. One of these binders lists industrial uses, with special reference to new applications created by war demands. The other furnishes technical data on fir plywood for engineers and architects. Additional information sheets will be sent to holders of the books as they are released from time to time.

OIL BURNERS

Peabody Engineering Corporation
580 Fifth Avenue, New York, N. Y.

Two new standard size 4-page bulletins illustrating and describing the company's oil burning equipment. Bulletin No. 107 explains the operating principles and features of type CD wide range systems. Bulletin No. 108 deals with type A and type H burners.

MOTORS

General Electric Company
Schenectady, New York

Standard size, 40-page bulletin GED-1017, deals with the selection and application of motors, various types of motor enclosures, motor maintenance, selection of A.C. control, and kindred subjects. Bulletin is arranged for quick reference.

CONTROLLED ATMOSPHERES

Tenney Engineering, Inc.
8 Elm Street, Montclair, N. J.

A new 12-page, two color booklet illustrates and describes the company's standard high altitude chamber units having temperature ranges from — 70F to 140F. Weathering cabinets, constant temperature bath tables, and temperature and humidity cabinets are also covered, and examples are given of important installations and the specifications applying to them.

PIPING

Bonney Forge & Tool Works
Allentown, Pa.

Standard size, 16-page bulletin WT-31, illustrates and describes WeldOlets, ThredOlets, and Socket-End WeldOlets. Typical installations are shown and explained, and stock sizes, weights, and list prices given.

BLOWERS

Ilg Electric Ventilating Company
2850 N. Crawford Avenue, Chicago, Illinois

A colorful new 8-page, 8½ x 11 in. brochure, containing 42 duotone illustrations, outlines the part played by the company's propeller fans, blowers, and unit heaters in both the present war and World War I.

MOTORS

Century Electric Company
1806 Pine Street, St. Louis, Mo.

Seven new 4-page standard size bulletins have been prepared and distributed to the trade in order to promote better maintenance, installation and adjustment of the company's various types of electric motors. Cut-a-way views and descriptive matter explain the typical features.

HEAT TRANSFER

International Nickel Company, Inc.
67 Wall Street, New York, N. Y.

A 16-page, standard size bulletin prepared by the Company's Research Division. Includes information for determining overall heat transfer rates, various factors influencing heat transfer through metallic walls and the thermal conductivities of metals and alloys commonly used in the construction of process equipment.

CONTROLS

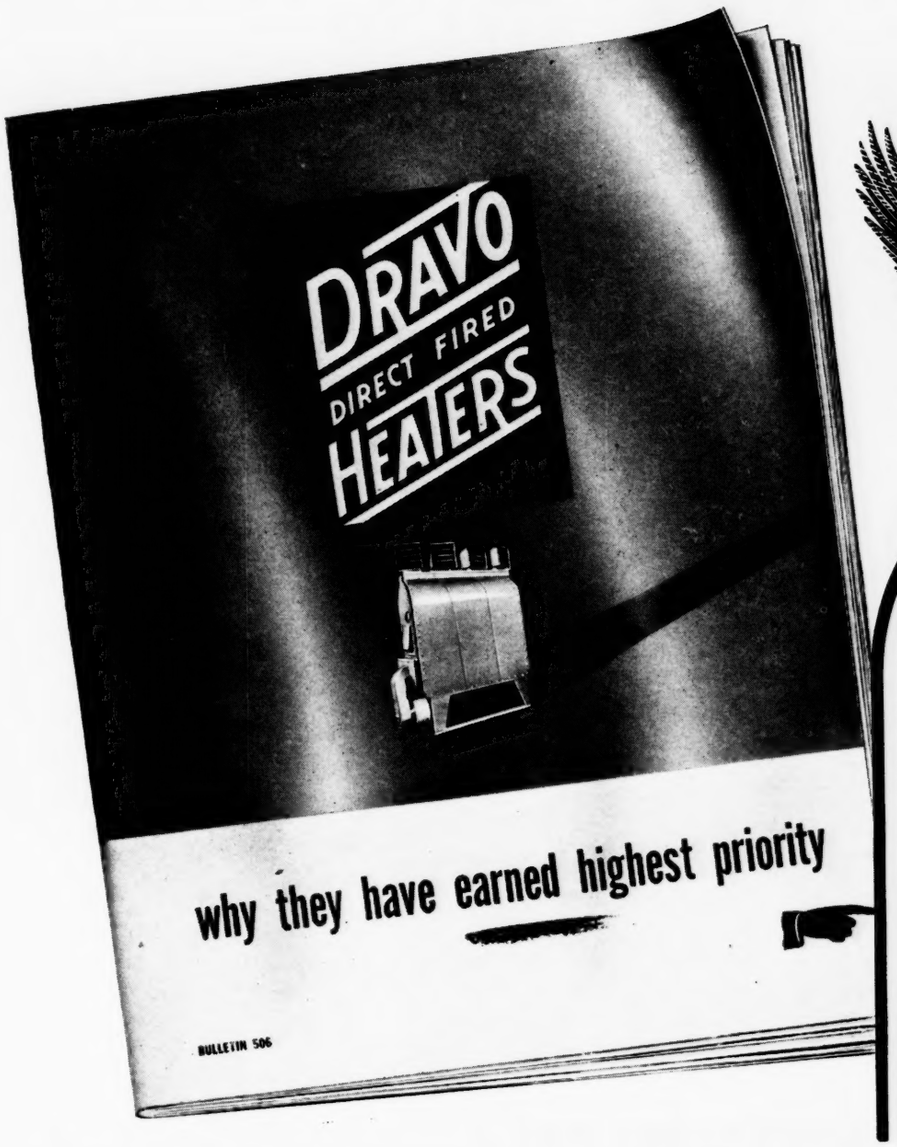
Wheelco Instruments Company
Harrison and Peoria Sts., Chicago, Illinois

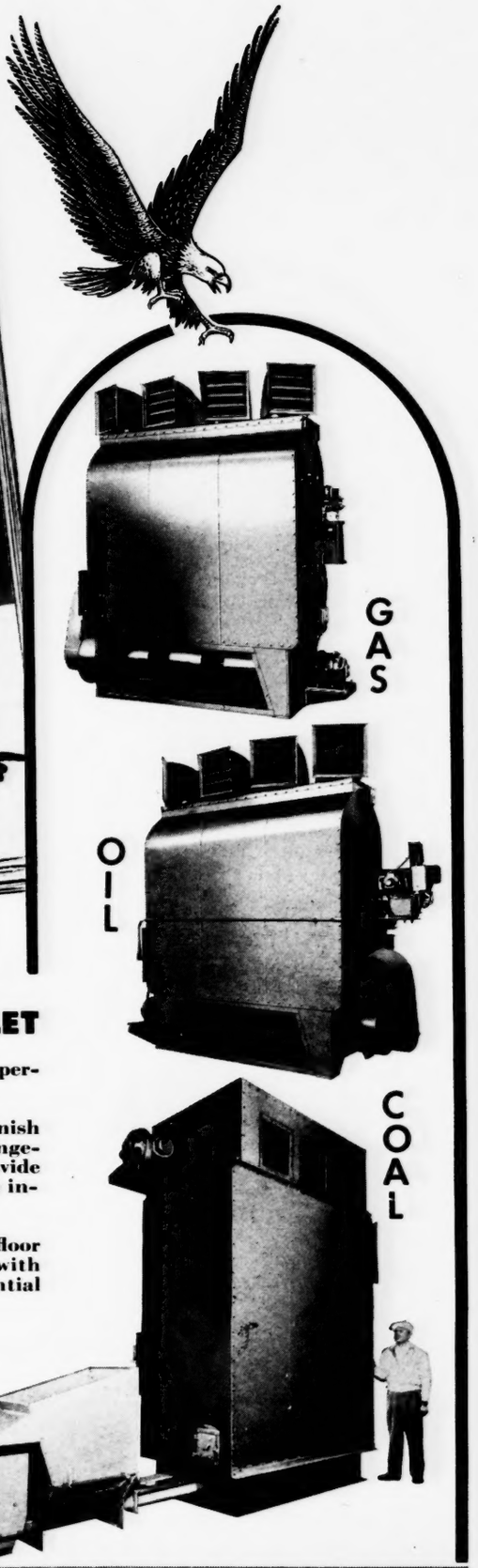
A new 6-page bulletin supplementing the company's thermocouple data book S2-3 and interpreting the recently amended WPB conservation order L-134 as it applies to the use of thermocouples, recommends and describes couples and tubes made of materials not prohibited by the order. It is intended as a convenient selection guide.

STEAM GENERATORS

Vapor Car Heating Company, Inc.
80 East Jackson Boulevard, Chicago, Ill.

Standard size, 4-page, two-color bulletin, No. 112, illustrates and describes the company's packaged steam generator, valves, traps, thermostatic controls, motorized valves and dampers, heat exchangers, and similar equipment.





NINE QUICK FACTS FROM THIS NEW BOOKLET

1. By eliminating the need for a boiler plant, these heaters save critical materials, man-hours and money.
2. Dravo Direct Fired Heaters give instant heat when the starter button is pushed.
3. Maximum heat utilization is secured from fuel. All heat except stack loss is utilized.
4. The most economical fuel available for automatic firing, natural gas, light or heavy fuel oil, or coal, is used.
5. Lower maintenance cost due to simplification, such as eliminating freeze-ups, broken traps, leaking valves, etc. No moisture from steam leaks to rust material stored in heated areas.
6. Saving in labor costs; can be operated by maintenance man.
7. The system can be used to furnish summer air circulation. Arrangements can easily be made to provide outside fresh air. Filters can be installed on air intakes.
8. Heat is delivered over an entire floor area or to a localized section with minimum temperature differential between floor and ceiling.
9. These heaters can be installed during building construction for temporary heat. Very little labor is required for their installation.

Bulletin No. 506 contains a complete description of design and construction of Dravo Direct Fired Heaters for gas, oil or coal; also tabular comparisons showing metal and fuel savings which contribute to the war effort. Send for your copy.

DRAVO CORPORATION

HEATER DEPARTMENT

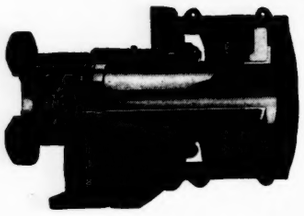
DRAVO BUILDING — *Sales Offices in Principal Cities* — PITTSBURGH, PA.

HOW TO KEEP VITAL STEAM LINES AT TOP EFFICIENCY FOR THE DURATION

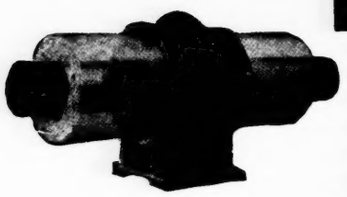
And for Years Afterward

4 VALUABLE ADSCO SUGGESTIONS

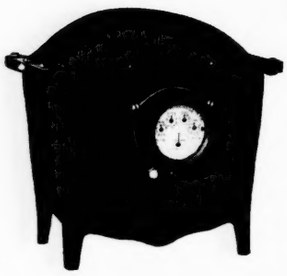
1 For underground lines use sectional ADSCO-Bannon Tile Conduit with base drain. Insulated with ADSCO Filler Insulation, a "Fiberglas" product, it provides a permanent installation at low first cost and high thermal efficiency.



2 Determine expansion and contraction of the pipe line carefully, allowing an ample factor of safety. Use ADSCO Piston-Ring Expansion Joints. They can be unpacked and repacked under full operating pressure without interruption to service.



3 Install pipe alignment guides and pipe anchors made by ADSCO. They are essential to avoid undue strain on fittings and expansion joints; good assurance against future line failure.



4 Know your actual steam consumption for heating or process purposes. Install Condensation or Steam Flow Meters. ADSCO can furnish either kind to help you detect steam losses and improve utilization.

● WRITE FOR CATALOG 35V

AMERICAN DISTRICT STEAM COMPANY NORTH TONAWANDA N. Y.

ADSCO HAS BEEN BUILDING "UP-TO-DATE" STEAM LINE EQUIPMENT *for over 60 years*

WITH THE MANUFACTURERS

AMERICAN MACHINE AND METALS, INC.

announces that its East Moline plant was presented on October 1 with the Army-Navy Production Award for high achievement in the production of war materials at ceremonies held October 1.

PENN ELECTRIC SWITCH CO.,

effective November 1, will move its Detroit office, formerly at 2631 Woodward Ave., to 7 East Grand, Highland Park Branch, Detroit. E. M. Smith is branch manager.

TUBE-TURNS INCORPORATED,

Louisville, recently won the dictinction of being the first war industry plant in the state of Kentucky to receive the Army and Navy E flag for outstanding production efficiency. Brief, colorful ceremonies were held at the plant September 18, at which the award was presented before a crowd of more than 3000 employees and their families. Individual Army-Navy E pins were later distributed to every employee. Characteristic of the nation's aroused industrial might, W. H. Girdler, president of the company, said in accepting the award, "we have just begun . . . our production in the next twelve months will be three times more than in the past twelve months!"

PERSONALS AND PERSONNEL

ALLEN P. LIVAR

has been appointed chief engineer of the Airtemp Division, Chrysler Corporation, Dayton, Ohio.

Mr. Livar has served Airtemp since 1937 as chief heating engineer, and, in his new capacity, will take over the duties of R. G. Wyld, who has accepted the commission of Lieutenant, Senior Grade, in the U. S. Navy. After graduation from Georgia School of Technology, Mr. Livar immediately joined the United States Navy. Following World War I, he served the United States Steel Corp. as a machinist apprentice. He entered the heating industry with American Radiator Company in the Birmingham plant, but was soon transferred to the Atlanta district office. Later he was with Pierce Butler and Pierce as branch manager of the Newark, N. J., office, and in 1926 joined The Trane Co. in New Jersey, becoming manager of their New York Office in 1929. Mr. Livar designed the Richvar radiator and a new line of coal and oil fired boilers for the Richmond Radiator Co. in 1932 when he was associated with that organization as vice-president in charge of sales and chief engineer. Later he was with Reynolds Metals Co. as general manager of the air conditioning division, where he worked until he joined Chrysler Airtemp in 1937.

E. E. SQUIER

who formerly represented Bell & Gossett Co. in its New Jersey territory, has been transferred to that company's home office and factory at Morton Grove, Ill.

HOWARD COONLEY,

on leave of absence as chairman of the board of the Walworth Company, who has been Chief of the Simplification Branch of the Conservation Division of War Production Board, has been made Deputy Director of the division.

E. G. BAILEY,

vice-president of The Babcock & Wilcox Company, New York, was presented with the first Percy Nicholls Award "for notable scientific or industrial achievement in the field of solid fuels" at a banquet of the joint Fuels Conference of the Coal Division, A.I.M.E., and Fuels Division, A.S.M.E., St. Louis, Mo., September 30.

ROBERT C. SESSIONS

Robert C. Sessions

of the consulting engineering firm of Sessions & Sessions, Cleveland, has been appointed chief engineer of The Brown Fintube Company, Elyria, Ohio.

Mr. Sessions, a graduate of Worcester Polytechnic Institute in Electrical Engineering, was for some time in charge of the engineering and experimental division of Steel & Tubes, Inc., before entering consulting work. The consulting firm of Sessions & Sessions is being continued with offices in the Rockefeller Building, Cleveland, under the active direction of Frank L. Sessions, senior partner.

COMING EVENTS

NOVEMBER 10-11.—Seventh Annual Meeting of the Industrial Hygiene Foundation, Mellon Institute, Pittsburgh, Pa. Further information from Industrial Hygiene Foundation, 4400 Fifth Ave., Pittsburgh, Pa.

NOVEMBER 19-20. Refrigeration Equipment Manufacturers Association Conference. To be held at the Palmer House, Chicago, Ill. Cooperating organizations include: The National Refrigeration Supply Jobbers Association; the Refrigeration Engineers Society; and the Commercial Refrigerator Manufacturers Association. For further information, write to R. Kennedy Hanson, Executive Secretary of the REMA, 1107 Clark Building, Pittsburgh, Pa.

NOVEMBER 24-29.—War-Time Chemical Show and Exposition, to be held at the Hotel Sherman, Chicago, Ill. Further information from Marcus W. Hinson, manager of the exposition, National Chemical Exposition, 110 No. Franklin Street, Chicago, Illinois.

NOVEMBER 30-DECEMBER 4. — 15th National Exposition of Power and Mechanical Engineering at the 1942 National Power Show to be held at Madison Square Garden, New York, N. Y. For further information write Charles F. Roth, manager of the exposition, 480 Lexington Avenue, New York, N. Y.

H&V's PHOTOS

Page 21-25. Chas. M. Hiller, San Francisco, and Maynard L. Parker, Los Angeles.

Page 47. Hedrich-Blessing Studio for Albert Kahn Associated Architects and Engineers, Inc.

Page 48. Courtesy of Glenn L. Martin Company.

Page 50. Office of War Information photo.

* *Mr. Frank M. Bates, who engineered the Fleetwings' ventilating system. By error in an earlier ad, the designing was credited to the contractor who did a splendid job of installing the Ilg equipment.*

HE DREW THE PLANS* FOR FLEETWINGS' FANS

FRANK M. BATES, Chief Plant Engineer, encountered an exceptionally severe heat problem in the manufacture of Fleetwings' stainless steel BT-12 basic training planes. Two factors—removal of excessive heat, plus the direct radiant heat of the sun—and revitalizing the air—called for ventilators with motors capable of continuous operation under abnormal heat conditions.

THROUGH THE USE of standard ILG Self-Cooled Motor Propeller Fans mounted in weather-tight penthouses, the problem was solved—rapid air change is quick and positive under all weather conditions. And, due to the ILG exclusive self-cooled motor that "breathes," there is no danger of overheating . . . no effect from moisture condensation . . . costs are lowered all along the line!

FREE CATALOG
Ask for No. 141

ILG ELECTRIC VENTILATING CO., 2858 N. CRAWFORD AVE., CHICAGO, ILL.
OFFICES IN 39 PRINCIPAL CITIES • CONSULT YOUR PHONE DIRECTORY

ILG

Vitalized Ventilation

AND AIR CONDITIONING

AIR CHANGE...NOT JUST AIR MOVEMENT!

FOR LOW-COST HEATING, QUICK INSTALLATION AND METAL CONSERVATION

DIRECTHERM
UNIT HEATERS STOKER-FIRED

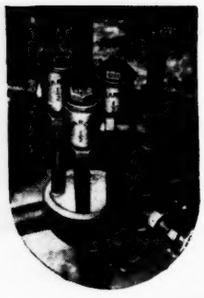
It is a self-contained unit and can be installed or moved in a few hours. No duct work, radiators, or pipes are necessary.

To tend a Directherm requires a minimum of attention. Once the automatic controls are set, they need not be changed. An unskilled man can take care of it . . . important in these days of labor shortage.

Made in 6 sizes (300,000-1,700,000 BTU).

AIRTHERM MANUFACTURING COMPANY

722 S. SPRING AVE., ST. LOUIS, MO.

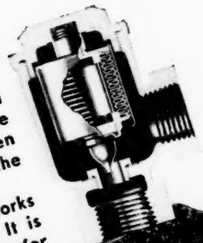


GUARDING INDUSTRY'S COAL PILE

Fuel is ⅓ the transport tonnage in the U. S. A. Dead condensate or air in a steam coil wastes fuel and slows up production. The Sarco Steam trap illustrated on this page says "get out" to spent condensate and gases — and "wait a while" to anything above its discharge temperature.

It is so inexpensive that it can be used on each steam coil, so no one part of the job can hold up another. Also it's wide open when cool — giving a quick start in the morning. Obviously it cannot freeze.

It is small, light, easy to install and works on all pressures within three ranges. It is the only thermostatic steam trap made for pressures up to 250 lbs. Ask for Catalog No. 250.



Sarco No. 9 Thermosfatic Steam Trap

144

SARCO SAVES STEAM

SARCO COMPANY, INC.
475 Fifth Avenue, New York, N. Y.
Sarco Canada Ltd., Federal Bldg., Toronto, Ont.

AIR CONDITIONING NOZZLES

Nozzles of unique Yarway Involute Design.

No internal parts or vanes to clog or erode.

Insure trouble-free air washing service.

Sizes and types for all requirements.

Many large users—installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-615.

YARNALL-WARING COMPANY
104 MERMAID AVENUE
PHILADELPHIA

YARWAY

HEATING AND VENTILATING

THE AIR CONDITIONING MONTHLY

A dehydrated meal for two. See Air Conditioning and Food Dehydration Reference Section Starting page 35